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Construction Engineering Research Laboratory

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Engineer Research and Development Center

Energy Manager Project Assistant

User Manual

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Foreword

This research was performed for the Director of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE) under Military Interdepartmental Purchase Request (MIPR) No. W26HBF90417169, Work Unit GS9, "Research to Develop Energy Management Software Program." The technical monitor was Hank Gignilliat, DAIM-FDF-VE.

The research was performed by the Energy Branch (E), of the Facilities Division (CF), of the U.S. Army Construction Engineering Research Laboratory (CERL). The CERL principal investigator was Elisabeth Jenicek. Larry Windingland is Chief, CEERD-CF-E; and L. Michael Golish is Chief, CEERD-CF. The CERL technical editor was William J. Wolfe, Information Technology Laboratory. The associated Technical Director was Gary W. Schanche, CEERD-CV-T. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

Contents

List of Figures and Tables

Figures

Tables

1 Introduction

Background

Between 1991 and 1999 approximately $200M of appropriated funds was invested in energy saving projects on Army installations. Energy funding is currently in short supply and the availability of funding is often short notice. Collecting the data required to prepare a project can be time consuming. Methodologies have varied. In short, energy managers find that they must expend great effort to successfully compete for limited funding.

Major Command (MACOM) and Headquarters evaluation, comparison, and ranking of individual submissions is often laborious since the calculation and narrative procedure for each submission is unique. This effort can be time consuming, if not impossible, due to the range of methodologies employed by installation staff.

Recently, the shortage of special energy funding increased the importance of funding those technologies that pay for themselves the quickest. At the same time, staffing is at an all time low and manpower is not available to collect data and prepare laborious calculations.

While there is a format for DD1391 reports and calculations, DD1391 includes no template for energy calculations and project narratives. Typically, each energy manager develops an individual methodology for analysis and narratives and includes them along with the DD1391 submission. Sometimes the analyses are over-simplified or contain factors of unknown origin. Some submissions contain mathematical errors or fundamental flaws in analytic methodologies.

The Energy Manager Project Assistant (PA) software program was created to fill this gap by providing a standard template for DD1391 energy project calculations and narratives. This program allows energy managers to quickly and accurately develop information for DD1391 project documentation and supporting economic analyses using standardized methodology. This new analysis tool saves time and ensures consistency in calculating energy and dollar savings by incorporating common assumptions and standardized algorithms. The user provides specific site information to the analysis and adds narrative to describe the project at their installation. The program prints an economic analysis summary sheet and list of input data and assumptions that can be included as part of the supporting documentation.

Generation of a traditional life cycle cost analysis (LCCA) form allows economic analysis to request/justify government funding. A second LCCA form allows the user to evaluate Energy Saving Performance Contract (ESPC) proposals for energy savings and economic viability. Complex projects not fitting the algorithms included here will require a more detailed energy savings study to provide input to the economic analysis.

Objective

The objective of this work was to provide documentation for the Energy Manager Project Assistant, to help energy managers create correct, complete DD1391 energy project calculations and narratives.

Approach

PA is an offshoot of the Renewables and Energy Efficiency Program (REEP). The energy and water conservation opportunities in REEP that generate the most savings were modified and included in PA. PA calculates resource and cost savings and generates DD1391 forms and supporting LCCA forms.

Other benefits to the PA program in addition to quick, accurate, and consistent project preparation include accurate "what-if" analyses of individual conservation opportunities within a building or set of buildings, and PA's capability to evaluate Energy Savings Performance contract (ESPC) proposals for estimated energy/cost savings.

Mode of Technology Transfer

It is planned that this software will be demonstrated at workshops and conferences. Articles will be published in venues such as the Public Works Digest and Engineer Update. The Project Assistant software and instruction manual are available for download on the CEERD web site:

http://owww.cecer.army.mil/emap/

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

SI conversion factors		
1 in.	=	2.54 cm
1 ft	=	0.305 m
1 yd	=	0.9144 m
1 sq in.	=	6.452 cm^2
1 sq ft	=	0.093 m^2
1 sq yd	=	0.836 m^2
1 cu in.	=	16.39 cm^3
1 cu ft	=	0.028 m^3
1 cu yd	=	0.764 m^3
1 gal	=	3.78 L
1 lb	=	0.453 kg
1 kip	=	453 kg
1 psi	=	6.89 kPa
°F	=	(°C x 1.8) + 32
1 lux	=	1 lumen/m^2
1 footcandle	=	0.0929 lux

2 Operating Instructions

Downloading and Installation of Software

Project Assistant can be downloaded from the CERL Strategic Energy Planning web site http://owww.cecer.army.mil/emap/. Follow the link in the sidebar entitled Project Assistant. Halfway down the web page is a link Download PA Software. Select this link and a download window will open. Define a location on your computer for the file pa.zip and save. The file will use 9.235 MB of disk space. Unzip the file and run the setup.exe file to install the program on your computer. The installed PA program will use 9.93 MB of disk space. Uninstall earlier versions of PA first using the Add/Remove Programs option in the windows Control Panel. PA is PC-compatible only.

Running Project Assistant

Figure 1 shows the opening window of PA. Select “OK” to activate the wizard and open the navigation window. The navigation window (Figure 2) contains five tabbed input windows. These tabs are: Installation, ECO, LCCA, DD 1391, and Misc.

Select the “Installation” tab to open a window containing an alphabetical list of every CONUS DOD installation (Figure 3). Select an installation from this window to feed the appropriate values to the Utility Rates and Fuel Cost fields in the “Installation” window. Those displayed are the default values—the latest available at the time PA was last updated. These values must be compared with current utility rates to obtain the most accurate analysis. The discount factor table is automatically selected based on the geographic region where the installation is located. Balloon descriptions appear when the cursor is held over a data field.

When all information is entered, select the “ECO” tab or the “Next” button on the bottom of the window. An “ECO” window (Figure 4) opens containing a list of 21 technologies that may be evaluated with PA. Select an ECO to begin entering assumptions.

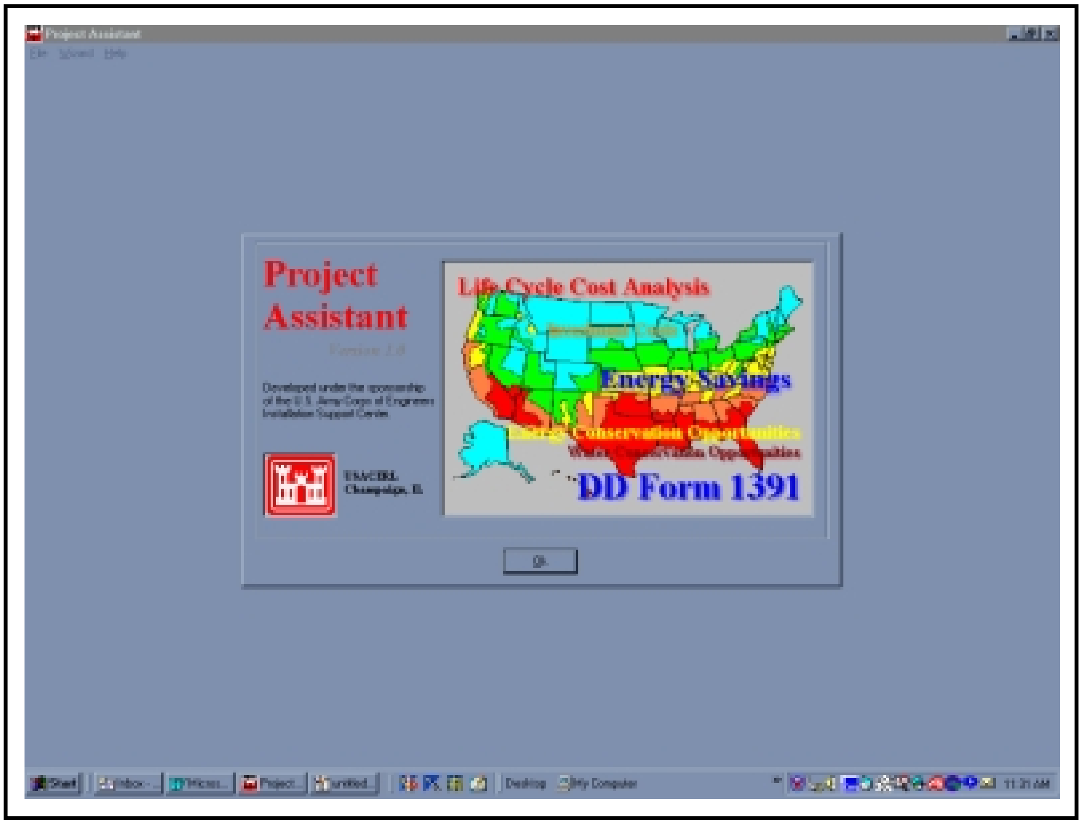

Figure 1. Project Assistant opening window.

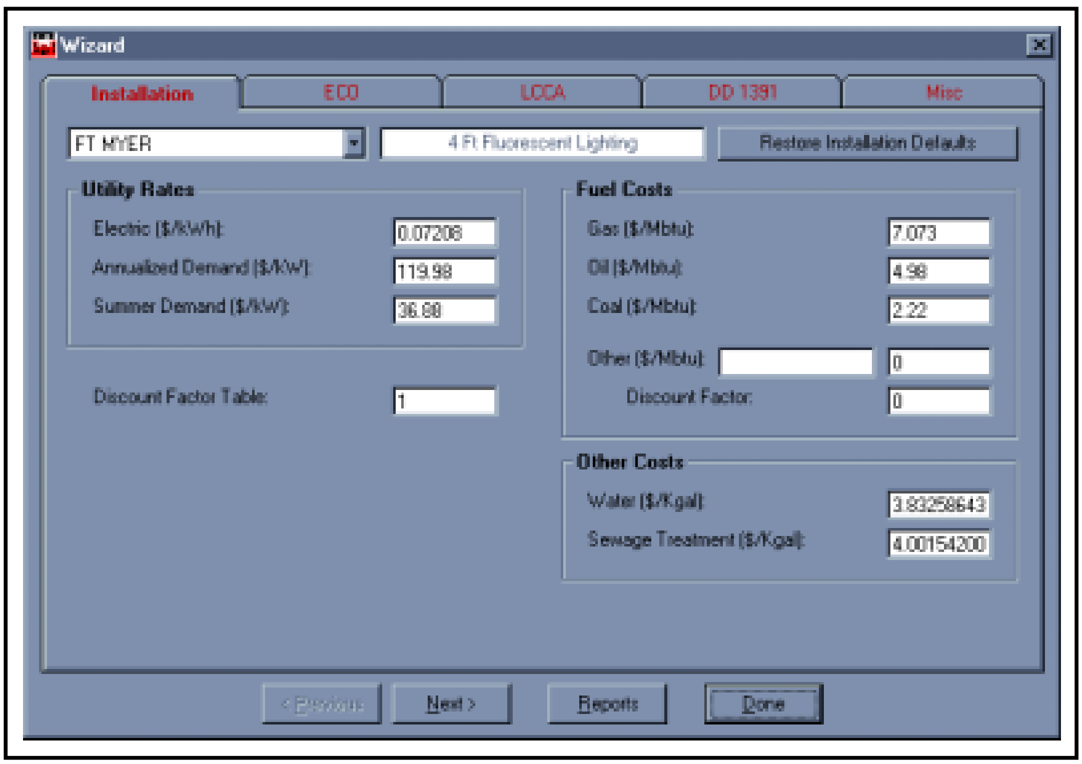

Figure 2. Project Assistant navigation window.

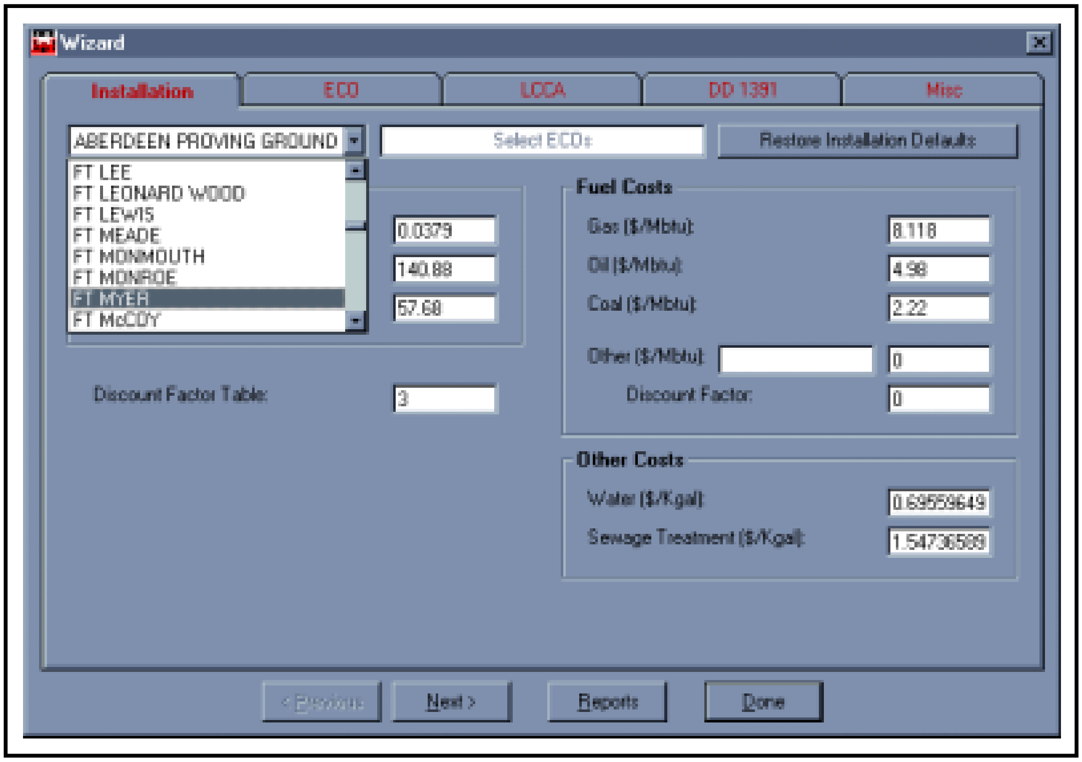

Figure 3. Project Assistant list of CONUS DOD installations.

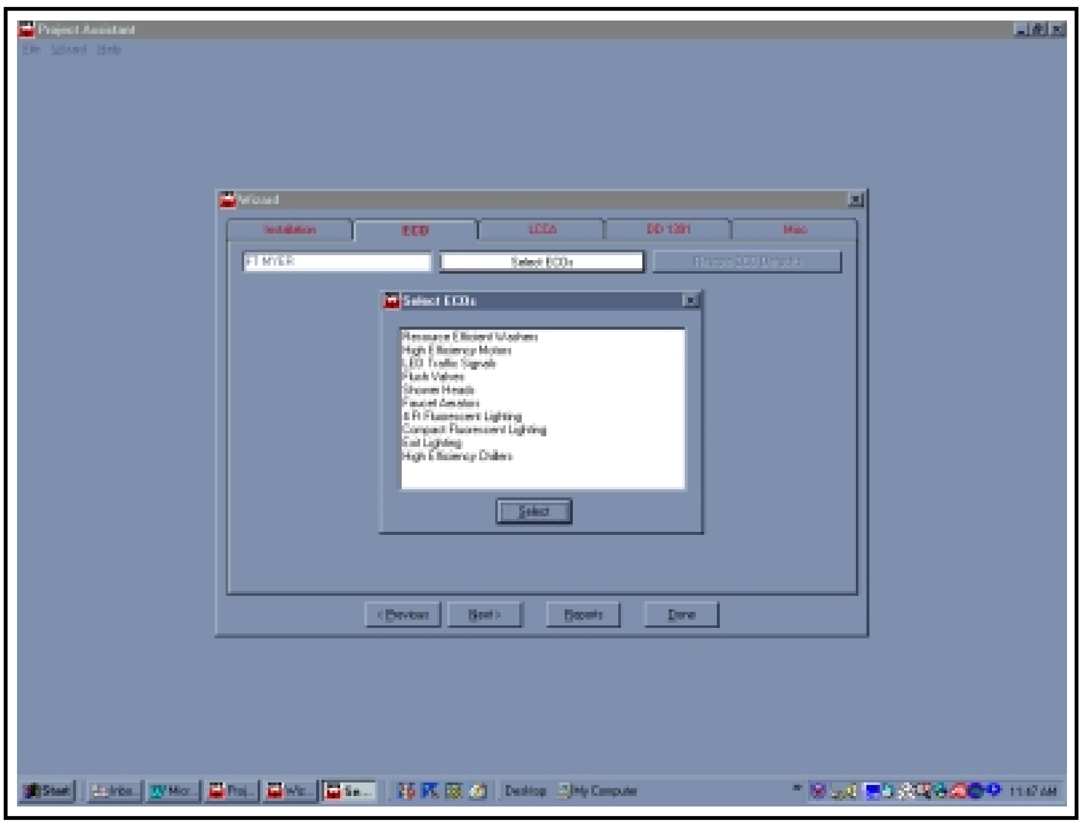

Figure 4. Project Assistant ECO window.

The “ECO” window contains ECO-specific assumptions required to evaluate each technology. There are a maximum of 30 assumptions for each technology. Some of the assumptions contain default values. Always check these assumptions for accuracy. The “Tab” key toggles through assumptions and the “Next” button will advance to the next page. Figure 5 shows a typical Assumptions window.

See Chapter 4 “Water Conservation Opportunities” (p 21), and Chapter 5, “Energy Conservation Opportunities” (p 32) for a detailed description of these assumptions and the calculations that use them. When evaluating a project with multiple ECOs, complete one full set of assumptions and then select the next ECO while holding the control key down (Figure 6). The “Design Info” button opens a window with information on ECO design and application.

Select the LCCA tab to enter information required to complete the Energy Conservation Investment Program (ECIP) economic analysis for energy projects. The LCCA window (Figure 7) contains more project-related entry fields. Enter the values and select either “Next” or “DD 1391” to continue. The LCCA economic analysis considers all costs and savings over a project’s life and uses fuel escalation rates and discounting to determine simple payback and savings to investment ratio.

The “DD1391” entry window contains three tabs (Figure 8). All pages need to be completed, either by using default or new information, before continuing to the last tab This material needs to be changed if the analysis includes multiple ECOs. Narrative developed for the DD1391 project documentation should include the technology description, plus site data such as building numbers and other pertinent information specific to the project.

The last tab, the “Misc.” window (Figure 9) contains fields for the Contractor’s Economic Assumptions and Other Costs. Contractor’s Economic Assumptions are required to evaluate ESPC projects. Other Costs are required for all projects. When finished here select the “Reports” button.

Generating Reports

The “Reports” window (Figure 10) lists four possible reports: (1) LCCA Summary (ECIP), (2) LCCA Summary (ESPC), (3) DD Form 1391, and (4) Assumptions. Select the appropriate report and the “View” button. The report may be printed or saved from the “View” screen. To save the report, select the “Export” icon (envelope). An “Export” window (Figure 11) will open. Select the desired format (Figure 12) and destination for the file. Close the report when finished. Select “Additional Reports” or “Done” when finished with this feature.

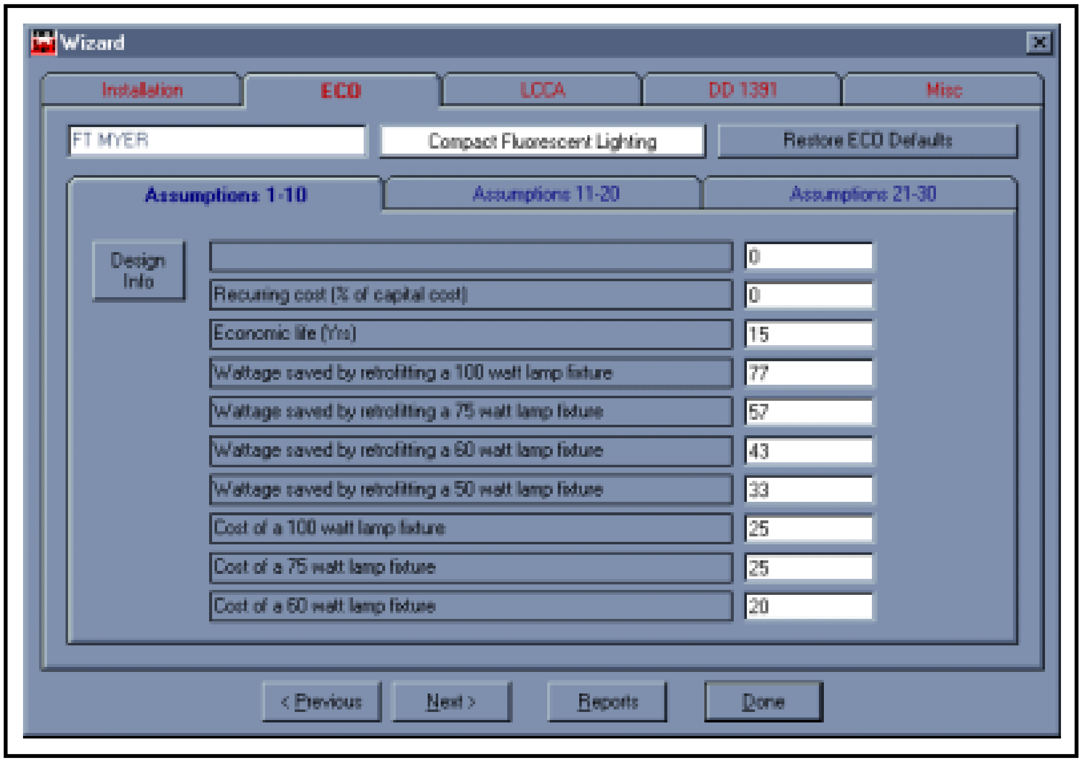

Figure 5. Project Assistant typical assumptions window.

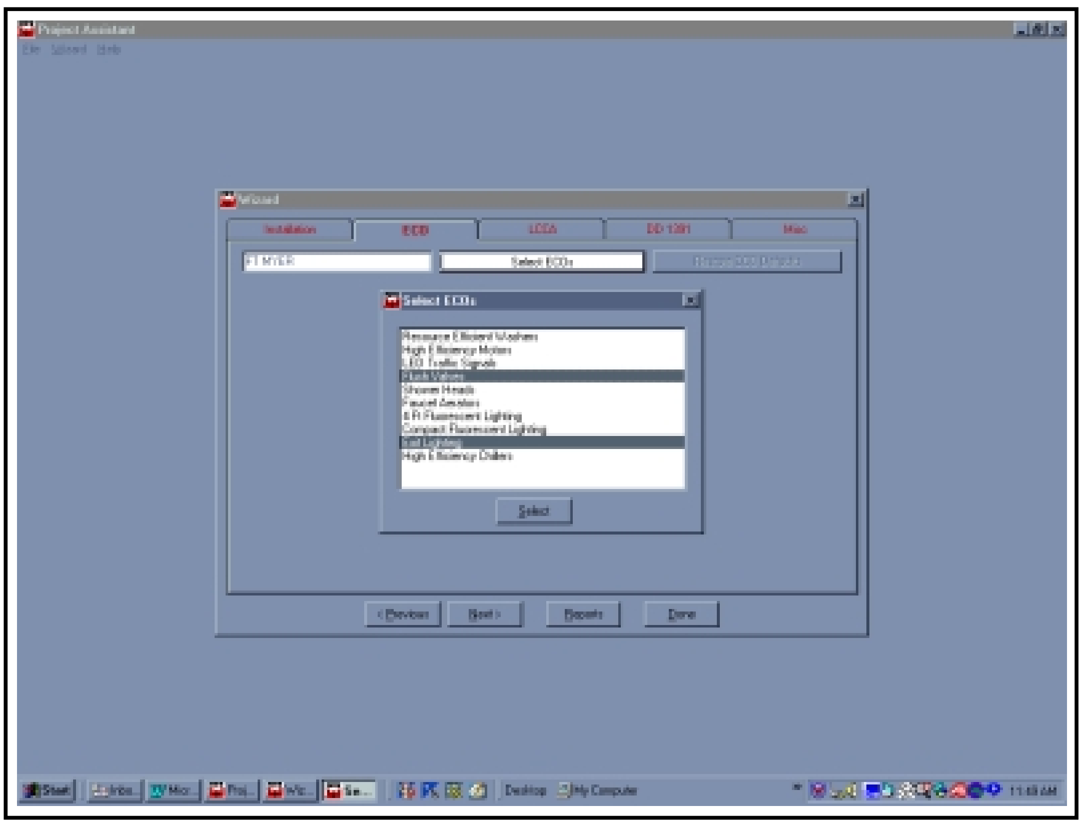

Figure 6. Selecting more than one ECO (while holding down CTRL key).

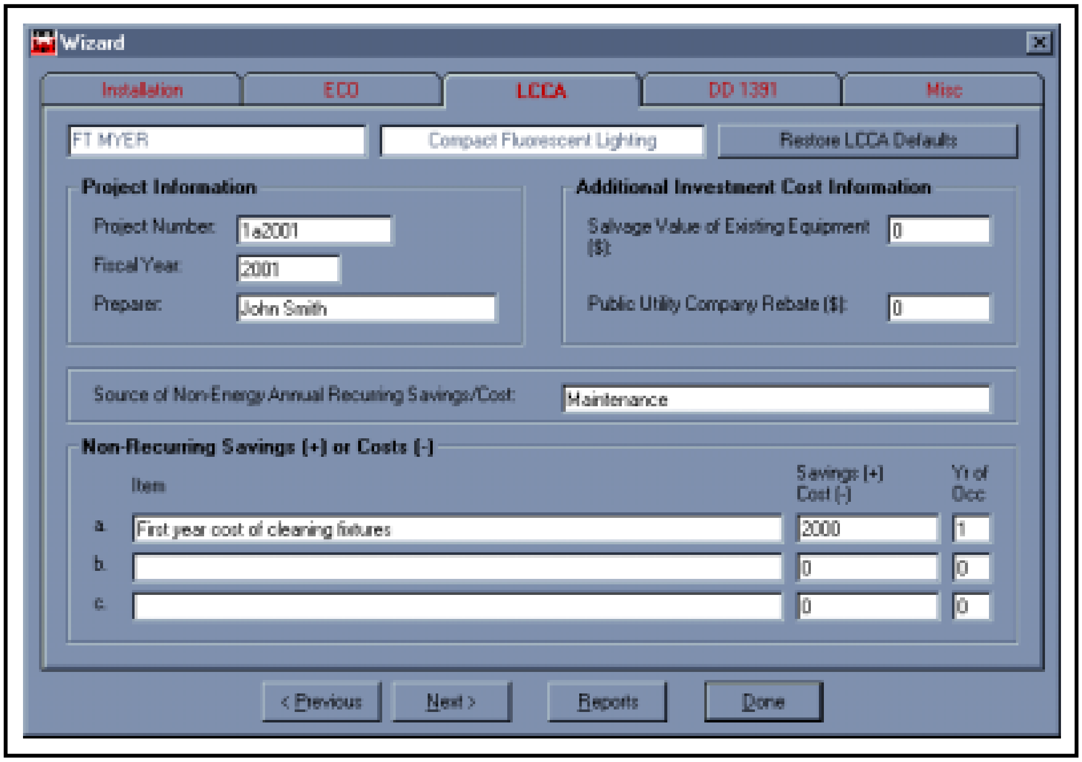

Figure 7. Project Assistant LCCA window.

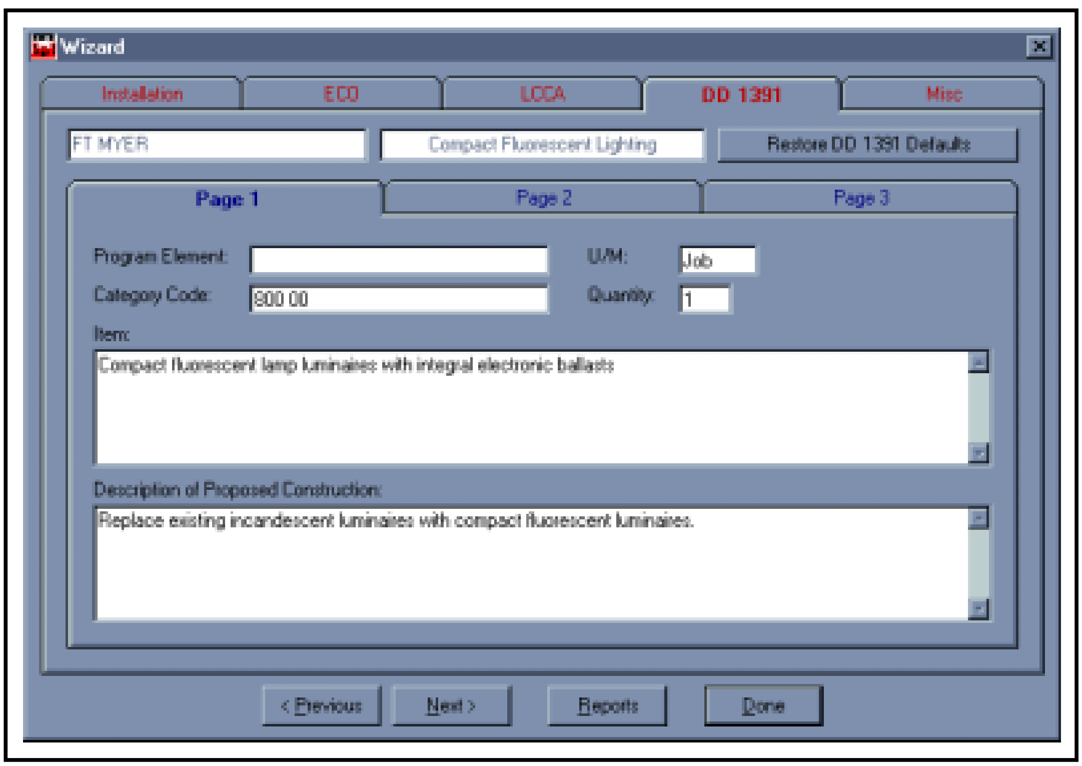

Figure 8. Project Assistant DD1391 entry window.

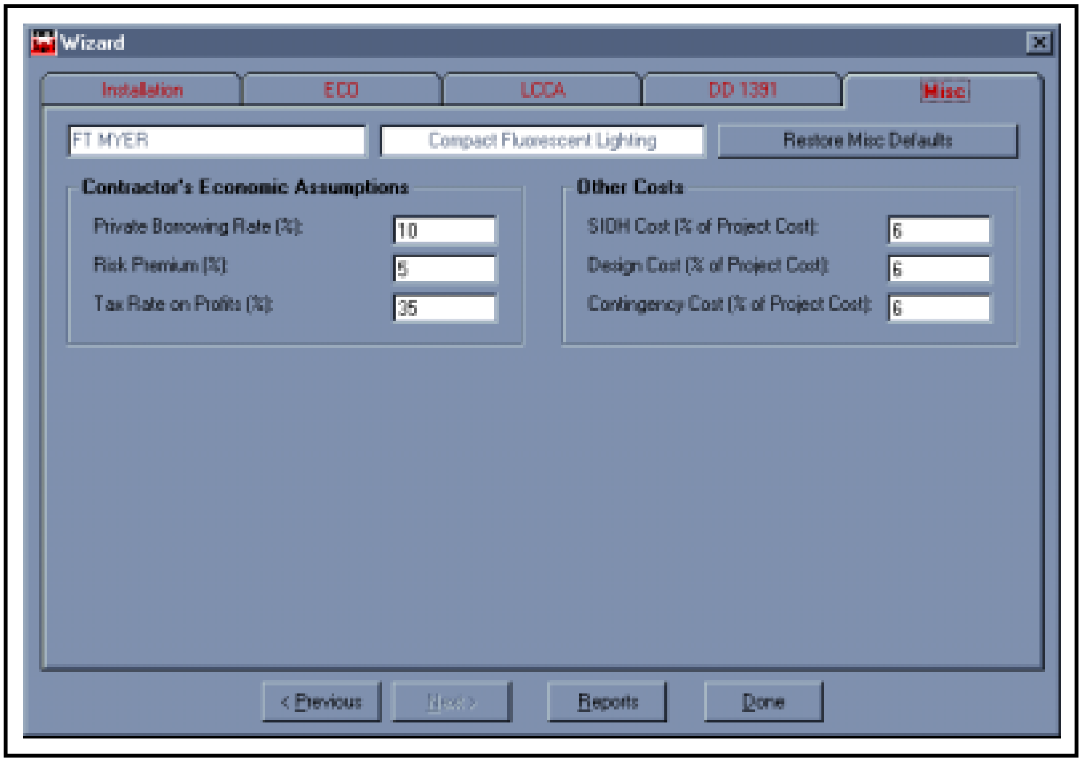

Figure 9. Project Assistant "Misc." window.

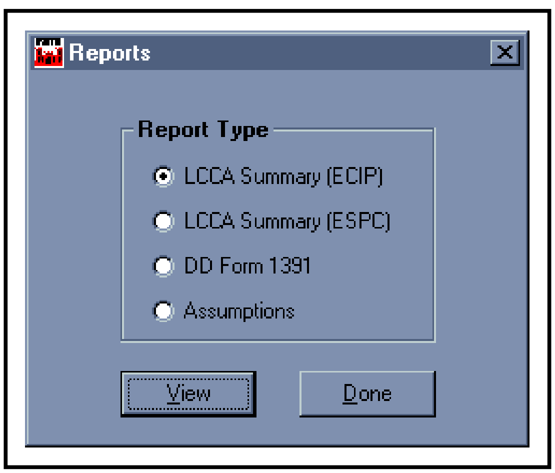

Figure 10. Project Assistant "Reports" window.

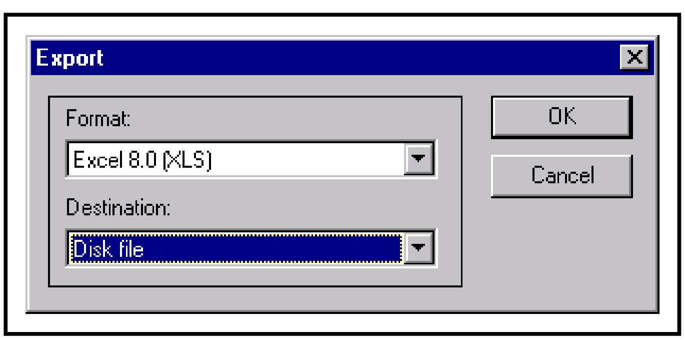

Figure 11. Export Window.

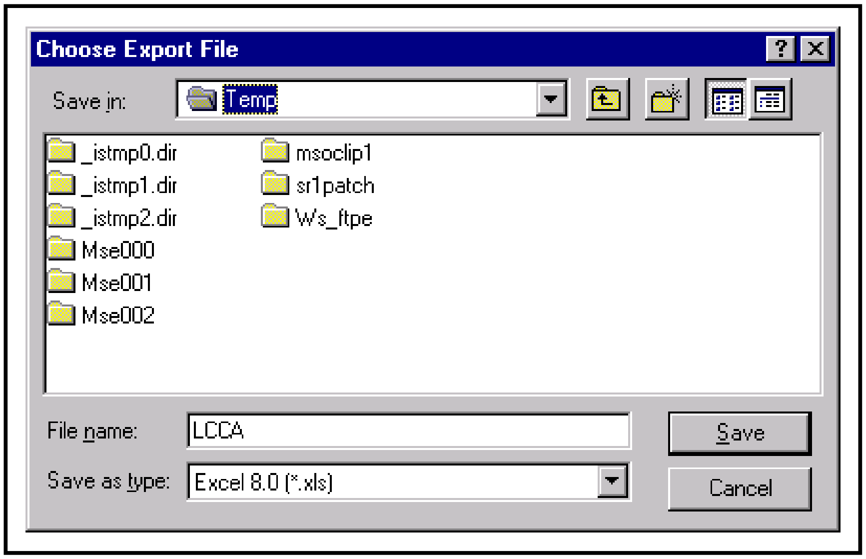

Figure 12. File format and file destination selection.

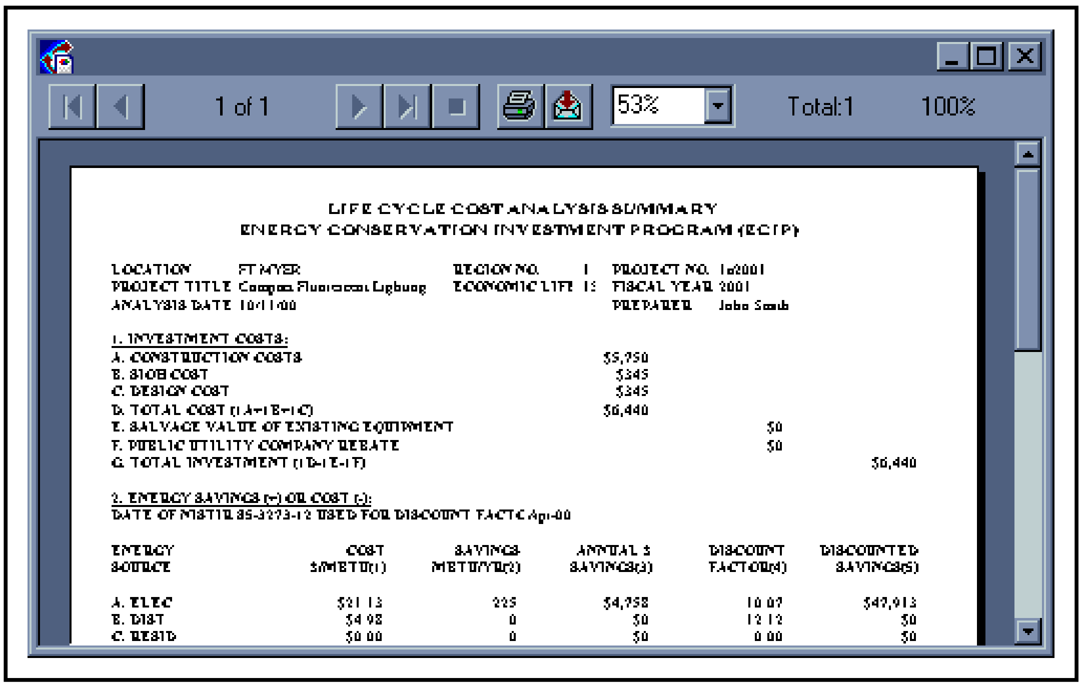

Figure 13. Sample Project Assistant "LCCA Summary (ECIP)" report in the "View" screen.

The "Assumptions" report provides all the assumed information for the specific installation and ECO being evaluated. The information can be edited to reflect any changes. This should be included with project documentation for reference purposes. Figure 13 shows a sample report in the "View" screen.

3 Installation Data and Common Assumptions

Default values found in the "Installation" window are taken from the REEP "INST Data" file. These values reflect the utility rate structure in place at each installation when the latest version of REEP was released. These rates should be reviewed and updated to reflect current conditions.

Installation Utility Rates

Utility rates are contained in the INST file, which is updated annually:

Electric
($E) cost of electricity in ($/KWh).

Annualized Demand
($D) electrical demand charge in ($/KW).

Summer Demand
($SD) electrical demand charge during Summer months only in ($/KW).

Installation Fuel Costs

Natural Gas
($NAG) cost of natural gas in ($/MBtu).

Oil
($O) cost of distillate oil in ($/MBtu).

Coal
($C) cost of coal in ($/MBtu).

Other
($oth) cost of other fuel type in ($/MBtu). This assumption requires input of other fuel type name and discount factor for other fuel type.

Installation Other Costs

Water
($W) cost of water in ($/Kgal).

Sewage Treatment
($S) cost of sewage treatment in ($/Kgal).

Discount Factor Table

Discount Factor Tables
These tables are extracted from the publication NISTIR, 85-3273-15, "Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis."

Common Variables

The following are variables common to all ECO calculations:

Number of Units To Replace
(#) Up to four different types/sizes can be analyzed.

Cost of Unit
($U) unit cost for each different type of motor, lighting fixture, or other technology to be analyzed.

Labor cost
($L) cost of labor to install a typical new unit.

Annual Hours of Operation
(hrs) number of hours each unit is operated over the course of 1 year.

Change in Annual Maintenance Cost
($maint) increase or decrease in annual maintenance costs as a result of this technology ($/year).

Diversity Factor
(d) percent of units operating at any one time (%).

Economic Life
(e) economic life of each technology is determined by ECIP criteria (in years).

Project Information

Project Number
The number the installation uses to identify the project.

Fiscal Year
The fiscal year in which the project is expected to be funded.

Preparer
The name of the project point of contact.

Additional Investment Cost Information

Salvage Value of Existing Equipment
This figure should include any salvage costs realized from the equipment that was removed. This may be a negative value if there is a cost for recycling the ECO materials ($).

Public Utility Company Rebate
Include any rebate from utility companies as part of a demand side management or similar program ($).

Annual Recurring Savings (+) or Costs (-)

Item
List recurring items.

Savings (+) Cost (-)
Show savings in ($) as a positive number and cost in ($) as a negative number.

Non-Recurring Savings (+) or Costs (-)

Item
List nonrecurring items.

Savings (+) Cost (-)
Show savings in ($) as a positive number and cost in ($) as a negative number.

Yr of Occ
The Year of Occurrence is the year the savings are realized or cost is incurred.

4 Water Conservation Opportunities

Resource Efficient Washing Machines

Background

Washing machines are becoming increasingly more resource efficient. Available today are both horizontal axis washing machines and more efficient vertical axis washing machines. They both use considerably less water than conventional washing machines. They use less energy and detergent, and spin dry clothes more thoroughly, therefore reducing the energy necessary to dry the clothes. The major brands have resource efficient washers available. This technology is more cost effective in barracks than family housing due to the higher usage rate. When considering replacement of washing machines at the end of their economic life, the incremental cost (difference in price between conventional washing machine and resource efficient washing machine) should be used in the LCCA. Although resource efficient washing machines cannot be financed with ECIP funding or O&M accounts, this water conservation opportunity (WCO) is a good candidate for ESPC and should be considered for all new purchases.

Water Assumptions

For family housing, the default values are four residents per household and one wash per day. The average family size is assumed to be four. The number of washes per day per dwelling is assumed to be one. The value for barracks will depend to some degree on local mission and can be obtained by informal survey. The default value is one washer for every 16 occupants. The number of washes per day per machine is assumed to be eight. The gallons saved per wash default value (19 gal) is based on a current value of 40 gal/wash and resource efficient value of 21 gal/wash of. A default value of 7 gal is used for hot water saved per wash, based on the average cycle being warm wash/cold rinse. Sewage will be reduced by an equivalent amount and these savings are included in the algorithm. It is imperative to use local values where these vary.

Energy Analysis

The energy saved is the energy needed to heat the hot water. This is equal to the difference between the water heater temperature and the groundwater temperature multiplied by the hot water saved and the thermal capacity of water. The resource efficient washer also has less electrical use of 0.14 kWh per load. No credit is taken for less electrical use in the dryer. The electrical pumping energy rate accounts for the reduced amount of energy used by the water distribution system pumps due to this retrofit. Electrical demand savings are not considered for this WCO.

References

Richard J. Scholze, Robert J. Nemeth, and Richard Gebhart, *Water Efficient Installations: Techniques and Technology* (U.S. Army Construction Engineering Research Laboratory [CERL], August 1998).

Whirlpool Corporation web site, http://www.whirlpool.com (Note that all the major brands have resource efficient washers available. This citation should not be interpreted as an endorsement of any particular brand.)

U.S. Environmental Protection Agency (USEPA) web site, which includes procurement information for water and energy conservation products and U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP) recommended products in the top 25 percent of energy efficiency:

http://www.energystar.gov
http://www.eren.doe.gov/femp/procurement/begin.html

DD1391 Info

Line 9
Item: Resource efficient washing machine.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing standard clothes washers with resource efficient washing machines.

Line 11
REQUIREMENT:

A. Project: This project will reduce the water consumption of the installation by replacing standard clothes washers with resource efficient washing machines. It will also reduce water heating energy and electrical energy.

B. Requirement: Existing clothes washers are inefficient and have been in service for at least 3 years. The EPAct (Energy Policy Act of 1992) requires execution of projects with a payback under 10 years.

C. Current Situation: Existing clothes washers consume excess water and energy compared to other available technologies that can reduce water and energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential water and energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(Wuse) Typical Water Consumption/Use

(HWuse) Hot Water Consumption/Use

(ΔW) Water Saved/Use

(ΔHW) Hot Water Saved/Use

(p) Persons/Unit
Number of persons using each unit.

(use) Uses/Day/Person
Loads of wash per day per person.

(Erate) Electrical Pumping Energy Rate
Default value is 0.01 measured in MBtu/Kgal.

(Tdiff) Hot Water Temperature Differential
Default value is 80 measured in °F.

(therm) Thermal Capacity of Water
A constant 8.33 Btu-°F-gal.

(NAGeff) NAG Water Heater Efficiency

(%NAG) Percent of Water heated by NAG

(Eeff) Electric Water Heater Efficiency

(%E) Percent of Water Heated by Electricity

(PPGeff) PPG Water Heater Efficiency

(%PPG) Percent of Water Heated by PPG

Formulas

Construction Cost = Σ [# * ($U + $L)]

Water Saved (Kgal/year) = Σ (# * p * use) * ΔW * (365/1000)

Water & Sewage Cost Savings ($/year) = Water Saved * ($W + $S)

Hot Water Saved (Kgal/year) = Σ(# * p * use) * ΔHW * (365/1000)

Water Heating Energy Savings (MBtu/year) = (Hot Water Saved/1000) * Tdiff * therm

Water Heating Cost Savings ($/year)= (Water Heating Energy Savings) * [$NAG * (%NAG/NAGeff) + $E * (%E/Eeff) + $PPG * (%PPG/PPGeff)]

Pumping Electricity Saved (MBtu/year) = Water Saved * Erate

Electricity Cost Savings ($/year) = Electricity Saved * $E

Annual Recurring Svgs/Cost ($/year) = Water & Sewage Cost Savings + $maint

Faucet Aerators

Background

Faucet aerators reduce water flow significantly and save hot water. Faucet aerators should be installed where the force of flow is important, as in washing hands or cleaning dishes. They will not save water where a specific volume of water is required, as in a custodian filling a bucket in a maintenance closet. This WCO allows separate calculations for family housing, barracks, and community facilities.

Water Assumptions

The default values assume existing faucets provide 5 gpm flow of water. The average faucet use is assumed to be 30 seconds long. Total water per faucet use before the retrofit is 2.5 gal with 1.25 gal of hot water. A faucet aerator is assumed to reduce water flow by 50 percent. Sewage will be reduced by an equivalent amount. These savings are included in the algorithm.

Energy Analysis

Groundwater temperature is assumed to be 55 °F, hot water temperature 155 °F and faucet temperature 105 °F. This gives a cold/hot ratio for water flowing through the faucet of 38:62. Adjust this ratio to account for local variations in temperature. These temperature assumptions give a hot water differential of 80 °F. The energy saved is the energy needed to heat the hot water. This is equal to the difference between the water heater temperature and the groundwater temperature multiplied by the hot water saved and the thermal capacity of water. The electrical pumping energy rate accounts for the reduced energy used by the water distribution system pumps due to this retrofit. Electrical demand savings are not considered for this WCO.

Faucet Aerator References

Richard J. Scholze, Robert J. Nemeth, and Richard Gebhart, *Water Efficient Installations: Techniques and Technology* (CERL, August 1998).

DD1391 Info

Line 9
Item: Water efficient faucet aerator.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Retrofit existing faucets with faucet aerators.

Line 11
REQUIREMENT:

A. Project: This project will reduce the water consumption of the installation by replacing existing faucet aerators with low flow aerators. It will also reduce water heating energy.

B. Requirement: Existing faucet aerators are inefficient, have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing systems consume excess water and energy compared to other available technologies that can reduce water and energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential water savings, as well as water heating energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(Wuse) Typical Water Consumption/Use

(HWuse) Hot Water Consumption/Use

(ΔW) Water Saved by a Faucet Aerator/Use

(ΔHW) Hot Water Saved by a Faucet Aerator/Use

(p) Persons/Faucet
Number of persons using each faucet.

(use) Uses/Day/Person
Uses per day per person.

(Erate) Electrical Pumping Energy Rate
Default value is 0.01 measured in MBtu/Kgal.

(Tdiff) Hot Water Temperature Differential
Default value is 80 measured in °F.

(therm) Thermal Capacity of Water
A constant 8.33 Btu-°F-gal.

(NAGeff) NAG Water Heater Efficiency

(%NAG) Percent of Water Heated by NAG

(Eeff) Electric Water Heater Efficiency

(%E) Percent of Water Heated by Electricity

(PPGeff) PPG Water Heater Efficiency

(%PPG) Percent of Water Heated by PPG

Formulas

Construction Cost = Σ[# * ($U + $L)]

Water Saved (Kgal/year) = [Σ(# * p * use)] * ΔW * (365/1000)

Water and Sewage Cost Savings ($/year) = Water Saved * ($W + $S)

Hot Water Saved (Kgal/year) = [Σ(# * p * use) * ΔHW * (365/1000)

Water Heating Energy Savings (MBtu/year) = (Hot Water Saved/1000) * Tdiff * therm

Water Heating Cost Savings ($/year)= (Water Heating Energy Savings) * [$NAG * (%NAG/NAGeff) + $E * (%E/Eeff) + $PPG * (%PPG/PPGeff)]

Pumping Electricity Saved (MBtu/year) = Water Saved * Erate

Electricity Cost Savings ($/year) = Electricity Saved * $E

Annual Recurring Svgs/Cost ($/year) = Water & Sewage Cost Savings + $maint

Shower Heads

Background

Many older shower heads provide a heavy stream of water that results in wasted water during a shower. Water saving shower heads provide superior spray patterns at lower flow rates, which saves both water and energy. It is possible to reduce the water used in showers by 60 percent with this retrofit. This also saves the energy required to heat and pump the excess hot water. It is important that high quality shower heads, those that maintain shower quality and achieve the 2.5 gpm requirement, are used. This WCO allows separate calculations for family housing, barracks and community facilities.

Water Assumptions

The default values assume existing shower heads provide 6 gpm flow of water. The average shower is assumed to be 5 minutes long. Total water use per shower before the retrofit is 30 gal with 18.8 gal being hot water. A low flow shower head is assumed to reduce water flow by 60 percent. Sewage will be reduced by an equivalent amount and these savings are included in the algorithm. It is imperative to use local values where these vary.

Energy Analysis

Groundwater temperature is assumed to be 55 °F, hot water temperature 155 °F and shower temperature 105 °F. This gives a cold/hot ratio for water flowing through the shower head of 38:62. Adjust this ratio to account for local variations in temperature. These temperature assumptions give a hot water differential of 80°F. The energy saved is the energy needed to heat the hot water. This is equal to the difference between the water heater temperature and the groundwater temperature multiplied by the hot water saved and the thermal capacity of water. The electrical pumping energy rate accounts for the reduced energy used by the water distribution system pumps due to this retrofit. Electrical demand savings are not considered for this WCO.

Low Flow Shower Head References

Richard J. Scholze, Robert J. Nemeth, and Richard Gebhart, *Water Efficient Installations: Techniques and Technology* (CERL, August 1998).

DD1391 Info

Line 9
Item: Low flow shower head.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Retrofit existing shower facilities with water saving shower heads.

Line 11
REQUIREMENT:

A. Project: This project will reduce the water consumption of the installation by replacing existing shower heads with low flow shower heads. It will also reduce water heating energy.

B. Requirement: Existing shower heads are inefficient, and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing systems consume excess water and energy compared to other available technologies that can reduce water and energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential water savings, as well as water heating energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(Wuse) Typical Water Consumption/Use
(gal) amount of water used for each shower.

(HWuse) Hot Water Consumption/Use
(gal) amount of hot water used for each shower.

(ΔW) Water Saved by a Low Flow Shower Head

(ΔW) Hot Water Saved by a Low flow Shower Head

(p) Persons/Shower Head
Number of persons using each shower head.

(use) Uses/Day/Person
Uses per day per person.

(Erate) Electrical Pumping Energy Rate
Default value is 0.01 measured in MBtu/Kgal.

(Tdiff) Hot Water Temperature Differential
Default value is 80 measured in °F.

(therm) Thermal Capacity of Water
A constant 8.33 Btu-°F-gal.

(NAGeff) NAG Water Heater Efficiency

(%NAG) Percent of Water Heated by NAG

(Eeff) Electric Water Heater Efficiency

(%E) Percent of Water Heated by Electricity

(PPGeff) PPG Water Heater Efficiency

(%PPG) Percent of Water Heated by PPG

Formulas

Construction Cost = Σ[# * ($U + $L)]

Water Saved (Kgal/year) = [Σ(# * p * use)] * ΔW * (365/1000)

Water & Sewage Cost Savings ($/year) = Water Saved * ($W + $S)

Hot Water Saved (Kgal/year) = [Σ(# * p * use) * ΔHW * (365/1000)

Water Heating Energy Savings (MBtu/year) = (Hot Water Saved/1000) * Tdiff * therm

Water Heating Cost Savings ($/year)= (Water Heating Energy Savings) * [$NAG * (%NAG/NAGeff) + $E * (%E/Eeff) + $PPG * (%PPG/PPGeff)]

Pumping Electricity Saved (MBtu/year) = Water Saved * Erate

Electricity Cost Savings ($/year) = Electricity Saved * $E

Annual Recurring Svgs/Cost ($/year) = Water & Sewage Cost Savings + $maint

Flush Valves

Background

Flush valves can be retrofitted with water saving devices that shorten the flush cycle of urinal and water closet valves without restricting the water flow. This allows the pressure necessary for effective cleansing using less water. Water saving devices installed in these flush valves have been found to save up to 50 percent of the water used by these fixtures. Because of the variation in valve models, ages, and conditions, expectations are that 30 to 40 percent of water can be saved. Installation should take a few minutes per valve and requires no special tools. It requires only the unscrewing of the outer cover, the removal of the inner core, the placement of the device over the plastic relief valve, and the replacement of the removed covers. These devices are not designed for use on newer, low consumption urinal or water closet flush valves. This WCO allows separate calculations for admin, barracks, community facilities, hospitals, research and development (R&D), and training buildings.

Water Assumptions

Water consumed by the existing urinal/water closet is assumed to be 5 gal/flush. A 40 percent savings would save 2 gal/flush. Sewage will be reduced by an equivalent amount and these savings are included in the algorithm. It is imperative to use local values where these vary.

Energy Analysis

The electrical pumping energy rate accounts for the reduced energy used by the water distribution system pumps due to this retrofit. Electrical demand savings are not considered for this WCO.

Flush Valve References

Richard J. Scholze, Robert J. Nemeth, and Richard Gebhart, *Water Efficient Installations: Techniques and Technology* (CERL, August 1998).

DD1391 Info

Line 9
Item: Flush valve retrofit device.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Retrofit existing urinal and water closet flush valves with water saving devices.

Line 11
REQUIREMENT:

A. Project: This project will reduce the water consumption of the installation by installing water saving devices on urinals and water closet flush valves.

B. Requirement: Existing flush valves are inefficient and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing systems consume excess water compared to other available technologies that can reduce water consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential water savings and may not meet water reduction goals.

Variables

(ΔW) Water Saved/Use

(p) Persons/Faucet
Persons per flush valve.

(use) Uses/Day/Person
Flushes per day per person.

(Erate) Electrical Pumping Energy Rate
Default value is 0.01 measured in MBtu/Kgal.

Formulas

Construction Cost = Σ[# * ($U + $L)]

Water Saved (Kgal/year) = [Σ(# * p * use)] * ΔW * (365/1000)

Water & Sewage Cost Savings ($/year) = Water Saved * ($W + $S)

Electricity Cost Savings ($/year) = Electricity Saved * $E

Annual Recurring Svgs/Cost ($/year) = Water & Sewage Cost Savings + $maint

5 Energy Conservation Opportunities

LED Traffic Signals

Background

Light Emitting Diodes (LEDs) are solid-state semiconductor devices that convert electrical energy directly into light. They can be extremely small and durable and provide longer lamp life than other sources. LEDs are being used extensively as a retrofit for incandescent exit signs and have been introduced as a retrofit for traffic signals. New LED materials and improved production provide brighter LEDs in an array of colors with higher efficacies than incandescent lamps. LED retrofits are available for arrows, pedestrian crossing signals, and railroad crossing signals as well.

Expected Life

Although LEDs have a life expectancy in excess of 10 years based on conservative projections of component failures, insufficient operating data is available to support this claim as yet because the technology is so new. Many manufacturers have a 5-year warranty on LED traffic signal heads. Consider these factors when entering a value for LED lamp life in PA.

Energy Use

The number of individual LEDs in a traffic signal varies according to their brightness. One red LED traffic signal head that contains 196 individual LEDs has a wattage of less than 10W compared with a 150W incandescent lamp that it can replace. A greater number of LEDs is required in green and amber traffic signal heads, increasing the cost of these colors. Amber lights operate about 3 percent of the time. Green traffic signal heads are more expensive due to the material used.

Visibility

The Institute for Transportation Engineers (ITE) is the primary standard setting body for traffic safety devices. Their standards are decades old and are incandescent specific. Some researchers have expressed concerns over the visibility of LED signals by color-deficient individuals. LED light is directional, which makes correct placement of signals critical. The ITE's specifications are currently being revised. They are only guidelines, and local and state governments ultimately decide what specifications to require for traffic lights. Organizations such as the California Department of Transportation developed their own traffic signal specifications that take into account the special characteristics of LEDs. Research on visibility and signal brightness requirements is ongoing.

Electrical Characteristics

Early LED traffic signal units had power factors less than 0.6. Products with power factors over 0.9 are now common. Low total harmonic distortion (THD) is also available, though there may be a tradeoff between power and THD. Load switching compatibility is an important power issue. The lower power and current of LED units can be incompatible with switching gear designed for incandescent lamps with higher power and current. Some users with old EDI load switches have either replaced them with digital switches or installed a capacitor across the load switch output to eliminate spikes. Some also recommend replacing the reflector and lens when completing an LED retrofit.

Reliability

LEDs currently being manufactured are rated for operating temperatures of 25 °C. At lower temperatures, they produce more light, at higher temperatures, less.

Maintenance

Relamping costs are lower for LEDs than for incandescents because of a longer relamping period. Signal system electrical component maintenance cost for LED systems is lower based on reduced electrical component failure due to smaller electrical system loads. Most signal system maintenance is due to mechanical failure of load switching contacts, field wiring, relays, etc. This savings has not been factored into the Project Assistant LCCA, but can be included by the user under Change in Annual Maintenance Cost in the "ECO" window.

Other Benefits

LEDs weigh less than conventional traffic signals. They are easier to use with newer traffic system controls. Occupational hazards are reduced since less time is spent relamping dangerous locations.

LED References

John Bullough, Kun Michelle Huang, and Kathryn Conway, *Optimizing the Design and Use of Light-Emitting Diodes for Visually Critical Applications in Transportation and Architecture*" (Lighting Research Center, 1998).

Philadelphia Municipal Energy Office, *Light Emitting Diodes for Traffic Signal Displays* (December 1995).

Lighting Research Center web site, http://www.lrc.rpi.edu/Ltgtrans/LED/

DD1391 Info

Line 9
Item: LED Traffic Signals.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Retrofit existing incandescent traffic signals with Light Emitting Diode (LED) technology.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy consumption of the installation by installing more efficient traffic lighting equipment.

B. Requirement: Existing traffic signals are inefficient, have been in service for at least 3 years, and the replacement project has a payback of 10 years or less.

C. Current Situation: Existing systems consume excess electrical power compared to other available technologies that can extend equipment life while reducing energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential saving in energy dollars, in reduced maintenance costs, and may not meet Federally mandated energy reduction goals.

Variables

(life) LED Lamp Life
Projected life of replacement traffic signals.

(EXlife) Existing Lamp Life
Projected life of existing traffic signals.

(EX$) Existing Lamp Cost
Cost of each existing lamp.

($Lspot) Cost of Labor To Spot Relamp
Labor and miscellaneous costs of relamping individual lamp failures.

($Lgroup) Cost of Labor to Group Relamp
Labor and miscellaneous costs of group relamping periodically.

(ΔW) Wattage Saved
Wattage saved by replacement of an incandescent signal with an LED signal.

Formulas

Existing Annual Maintenance Cost ($/year) = (EX$ + $Lspot) * Σ # * Hrs/EXlife)

LED Annual Maintenance Cost ($/year) = Σ(# * ($U+ $Lspot) * (Hrs/life)

LED Installation Cost ($) = Σ(# * ($U + $Lgroup))

Energy Saved (MBtu/year) = Σ(# * (ΔW * Hrs)) * 3.412/1,000,000

Recurring Savings ($/year) = (Existing Annual Maintenance Cost - LED Annual Maintenance Cost)

Energy Cost Savings ($/year) = Energy Saved* $E

Demand Savings (KW) = Σ(ΔW * # * S)/1,000
where S = 0.5 for red and green signals
0.9 for Red Arrow and Don't Walk
0.1 for Green Arrow

Demand Cost Savings ($/year) = Demand Savings * $D

LED Exit Lighting

Background

Almost every nonresidential building has exit signs indicating paths of egress. Observed individually, these fixtures consume only a moderate amount of energy. However, observed globally, these fixtures consume a phenomenal amount of energy since they run 24 hours per day, 365 days per year. Numerous retrofit options are available for exit lights.

Characteristics

Most exit signs in older facilities contain two 20 to 25W incandescent lamps. This ECO retrofits the existing lamps with a light emitting diode (LED) kit that has a double row of LEDs and attaches to either side of the interior of an existing exit sign. The kits are available in a variety of connections, including hard-wired. They provide low energy use, long life (they typically have a 25-year warranty), and eliminate the need for exit sign maintenance. Other retrofits are possible (i.e., new LED exit signs, no energy exit signs, electroluminescent exit sign fixtures, and compact fluorescent exit sign fixtures), but, unless a new fixture retrofit is desired, the LED retrofit kits are the most economical to implement.

LED Exit Sign References

E Source web site: http://www.esource.com

General Services Administration Lighting web site: http://www.fedlightgov.com/

Defense Logistics Agency (DLA) web site, "Lighting" includes descriptions of the latest available lighting technology and products: dscp103.dscp.dla.mil/gi/general/light1.htm

Line 9
Item: Light emitting diode exit signs.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing incandescent exit signs with LED exit signs.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy consumption of facilities by installing more efficient illumination equipment.

B. Requirement: Existing illumination systems are inefficient, have been in service for at least 3 years, and the replacement project has a payback of 10 years or less.

C. Current Situation: Existing systems consume excess electrical power compared to other available technologies that can improve lighting quality while reducing energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential saving in energy dollars, in reduced maintenance costs, and may not meet Federally mandated energy reduction goals.

Variables

(Δ) Wattage Saved
Wattage saved by replacement of an incandescent with an LED Exit sign (old watts-new watts).

(FAP) Fraction of Area on Perimeter
Fraction of lighted area within 15 ft of the perimeter of the building. Default value is 0.7.

(COP) A/C COP
Coefficient of performance: energy-efficiency of air conditioning. Default value is 3.

(NAGeff) NAG Heating Efficiency

(%NAG) Percent of Facility Heated by NAG

(Oeff) Oil Heating Efficiency

(%O) Percent of Facility Heated by Oil

(Ceff) Coal Heating Efficiency

(%C) Percent of Facility Heated by Coal

(otheff) Other Heating Efficiency

(%oth) Percent of Facility Heated by Other

Formulas

Construction Cost ($) = Σ(# * $U)

Demand Savings (KW) = (Σ # * ΔW) * d/1,000

Demand Cost Savings ($/year) = Demand Savings * $D

Lighting Electrical Energy Saved (MBtu/year) = Demand Savings * Hrs * (3.412/1,000)

Lighting Electrical Cost Savings ($/year) = Ltg Elec En Svd * $E

Cooling Energy Savings (MBtu/year) = (Ltg Elec En Svd * 0.27)/COP where 0.27 is the lighting cooling fraction

Cooling Cost Savings ($/year) = Cooling Energy Savings * $E

Heating Energy Saved (MBtu/year) = -(Ltg Elec En Svgs * 0.3 * FAP
where 0.3 is the lighting heating fraction

Heating Cost Savings ($/year) = Heating Energy Saved *
[($NAG * (%NAG/%NAGeff)) + ($O * (%O/Oeff)) +
($C * (%C/Ceff)) + ($oth * (%oth/otheff))]

4-Foot Fluorescent Lighting

Background

One often-instituted energy conservation retrofit involves the replacement of older magnetic ballasts and fluorescent lamps with new high-efficiency components. The replacement electronic ballasts and T8 lamps are designed to provide the same amount of light as the inefficient fixture while using significantly less energy and improving the quality of the light provided. An important secondary benefit of this ECO is the reduction in heat dissipated from the fixture, thus reducing cooling loads. Heating loads, however, will increase due to the reduced heat output from the lighting system. Therefore, heating savings are indicated as a negative value in the ECO analysis.

Ballast and Fluorescent Lamp Characteristics

Pre- and post-retrofit lighting fixture characteristics had to be assumed to evaluate this ECO. Pre-retrofit characteristics represent a standard magnetic ballast and half 34W energy saver rapid start (T-12) cool white lamps and half 40W rapid start (T-12) cool white lamps (efficacy = 60 lumens/watt). Post-retrofit characteristics represent an electronic ballast with 32W, T-8, 3500K fluorescent lamps (efficacy = 90 lumens/watt). Fixtures with four, three, and two lamps were retrofit with a two-lamp fixture and one-lamp fixtures were retrofit with a one-lamp fixture. Since the general retrofit for four and three-lamp fixtures reduces the number of lamps, this retrofit should not be used in areas that do not have sufficient illumination. In many cases throughout DOD, though, spaces are overlit, so this reduction should not cause any problems.

4-ft Fluorescent Lighting References

E Source web site: http://www.esource.com

General Services Administration Lighting web site: http://www.fedlightgov.com/

Defense Logistics Agency (DLA) web site, "Lighting" includes descriptions of the latest available lighting technology and products: dscp103.dscp.dla.mil/gi/general/light1.htm

DD1391 Info

Line 9
Item: 2X4-ft linear fluorescent luminaire with F32T8 lamps and electronic ballast.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing 2X4-ft F40T12/magnetic ballast fluorescent luminaires with new F32T8/electronic ballast luminaires.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy consumption of facilities by installing more efficient illumination equipment.

B. Requirement: Existing illumination systems are inefficient, have been in service for at least 3 years, and the replacement project has a payback of 10 years or less.

C. Current Situation: Existing systems consume excess electrical power compared to other available technologies that can improve lighting quality while reducing energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential saving in energy dollars, in reduced maintenance costs, and may not meet Federally mandated energy reduction goals.

Variables

(Δ) Wattage Saved
Wattage saved by retrofit/replacement to T8 lamps and electronic ballasts (old watts-new watts).

(FAP) Fraction of Area on Perimeter
Fraction of lighted area within 15 ft of the perimeter of the building. Default value is 0.7.

(COP) A/C COP
Coefficient of performance: energy-efficiency of air conditioning. Default value is 3.

(NAGeff) NAG Heating Efficiency

(%NAG) Percent of Facility Heated by NAG

(Oeff) Oil Heating Efficiency

(%O) Percent of Facility Heated by Oil

(Ceff) Coal Heating Efficiency

(%C) Percent of Facility Heated by Coal

(otheff) Other Heating Efficiency

(%oth) Percent of Facility Heated by Other

Formulas

Construction Cost ($) = Σ(# * $U)

Demand Savings (KW) = (Σ # * ΔW) * d/1,000

Demand Cost Savings ($/year) = Demand Savings * $D

Lighting Electrical Energy Saved (MBtu/year) = Demand Savings * Hrs * (3.412/1,000)

Lighting Electrical Cost Savings ($/year) = Ltg Elec En Svd * $E

Cooling Energy Savings (MBtu/year) = (Ltg Elec En Svd * 0.27)/COP where 0.27 is the lighting cooling fraction

Cooling Cost Savings ($/year) = Cooling Energy Savings * $E

Heating Energy Saved (MBtu/year) = -(Ltg Elec En Svgs * 0.3 * FAP where 0.3 is the lighting heating fraction

Heating Cost Savings ($/year) = Heating Energy Saved * [($NAG * (%NAG/%NAGeff)) + ($O * (%O/Oeff)) + ($C * (%C/Ceff)) + ($oth * (%oth/otheff))]

Compact Fluorescent

Background

Compact fluorescent lighting has steadily gained popularity as lamp costs decline and the color rendition of lamps improves. Replacing incandescent lamps with compact fluorescents not only saves large amounts of energy at the light fixture itself, but it also reduces the cooling load on the HVAC system. Compact fluorescent lamps are used in this ECO to replace incandescent lamps that have wattages of 100W or less. For wattages higher than 100W, it is more reasonable to replace those lamps with a source that has a higher efficacy. As in the 4 ft fluorescent fixture, heating load increases, so heating savings are represented as a negative number in the ECO analysis.

Lamp Characteristics

A diverse range of compact fluorescents are on the market. They range in wattages from 5 to 42W and are available just as lamps that require a ballast to run or as self-ballasted with either a magnetic or electronic ballast and a standard screw base for direct retrofit purposes.

Compact Fluorescent Lighting References

E Source web site: http://www.esource.com

General Services Administration Lighting web site: http://www.fedlightgov.com/

Defense Logistics Agency (DLA) web site, "Lighting" includes descriptions of the latest available lighting technology and products: dscp103.dscp.dla.mil/gi/general/light1.htm

DD1391 Info

Line 9
Item: Compact fluorescent lamp luminaires with integral electronic ballasts.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing incandescent luminaires with compact fluorescent luminaires.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy consumption of facilities by installing more efficient illumination equipment.

B. Requirement: Existing illumination systems are inefficient, have been in service for at least 3 years, and the replacement project has a payback of 10 years or less.

C. Current Situation: Existing systems consume excess electrical power compared to other available technologies that can improve lighting quality while reducing energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential saving in energy dollars, in reduced maintenance costs, and may not meet Federally mandated energy reduction goals.

Variables

(Δ) Wattage Saved
Wattage saved by replacement of incandescent with compact fluorescent lighting (old watts-new watts).

(FAP) Fraction of Area on Perimeter
Fraction of lighted area within 15 ft of the perimeter of the building. Default value is 0.7.

(COP) A/C COP
Coefficient of performance: energy-efficiency of air conditioning. Default value is 3.

(NAGeff) NAG Heating Efficiency

(%NAG) Percent of Facility Heated by NAG

(Oeff) Oil Heating Efficiency

(%O) Percent of Facility Heated by Oil

(Ceff) Coal Heating Efficiency

(%C) Percent of facility heated by Coal

(otheff) Other Heating Efficiency

(%oth) Percent of Facility Heated by Other

Formulas

Construction Cost ($) = Σ(# * $U)

Demand Savings (KW) = (Σ # * ΔW) * d/1,000

Demand Cost Savings ($/year) = Demand Savings * $D

Lighting Electrical Energy Saved (MBtu/year) = Demand Savings * Hrs * (3.412/1,000)

Lighting Electrical Cost Savings ($/year) = Ltg Elec En Svd * $E

Cooling Energy Savings (MBtu/year) = (Ltg Elec En Svd * 0.27)/COP
where 0.27 is the lighting cooling fraction

Cooling Cost Savings ($/year) = Cooling Energy Savings * $E

Heating Energy Saved (MBtu/year) = -(Ltg Elec En Svgs * 0.3 * FAP
where 0.3 is the lighting heating fraction

Heating Cost Savings ($/year) = Heating Energy Saved * [($NAG * (%NAG/%NAGeff)) +
($O * (%O/Oeff)) + ($C * (%C/Ceff)) + ($oth * (%oth/otheff))]

High Wattage Incandescent

Background

Incandescent lighting is one of the simplest and most versatile lighting systems to implement because ballasts are not required and controls are simple. It is the least expensive lighting system to install, but it is also the least efficient lighting system used today. Because of the low initial cost and ease of installation, incandescent lighting was commonly used in many areas. It is still used, almost exclusively, in residential applications. Less than 15 percent of the energy used by an incandescent lamp is converted to visible light. The rest is converted to heat.

Replacement Technology

This ECO proposes two different retrofits to replace the majority of the high wattage (greater than or equal to 150W) incandescent lamps: fluorescent lighting and metal halide lighting. Compact fluorescent lamps cannot provide enough light to replace all high wattage incandescent lamps. Two different systems are used so the majority of the many applications in which incandescent lamps are used could be covered. The retrofits achieve significant energy savings while maintaining equivalent light output and a high color rendition.

Fluorescent lighting is recommended to replace the incandescent fixtures that provide general illumination. The retrofit includes T8 lamps and electronic ballasts. Energy costs are cut by approximately 75 percent and fluorescents maintain color rendition. Metal halide is recommended to replace the incandescent lamps used in downlights and spotlights. Energy costs are reduced by approximately 50 percent and metal halide provides good color rendition with a color similar to the fluorescent retrofit.

Energy Analysis

Table 1 shows the energy characteristics of each lighting system. Lighting also affects the heating and air conditioning systems in a building. A simplified method was used to estimate the effects that more efficient lighting technologies will have on the HVAC systems (R.A. Rundquist Associates). This is used to estimate savings and costs due to less heat being generated by the lighting systems. When calculating the increase in heating demand, this ECO uses a multiplier for a perimeter area fraction. The fraction of area on the perimeter of a building is the fraction of a building's area within 15 ft of an outside wall. This is necessary since it was assumed that only that fraction of the building has a heat load that could be offset by the heat the lighting system generates. To arrive at this number, the dimensions of an average building on an installation were assumed to be 50x130 ft. The user can change this number. A diversity factor used in the calculations accounts for all lights not operating at any given time.

High Wattage Incandescent References

E Source web site: http://www.esource.com

General Services Administration Lighting web site: http://www.fedlightgov.com/

Defense Logistics Agency (DLA) web site, "Lighting" includes descriptions of the latest available lighting technology and products: dscp103.dscp.dla.mil/gi/general/light1.htm

Table 1. Energy characteristics of each lighting system.

Original System	Fluorescent Retro	MH Retro
150 watts	1 lamp T8 system (30 watts)	75 watts (lamp wattage is 50W)
200 watts	2 lamp T8 system (60 watts)	95 watts (lamp wattage is 70W)
300 watts	3 lamp T8 system (90 watts)	125 watts (lamp wattage is 100W)
400 watts	no retrofit for this	175 watts (lamp wattage is 150W)

DD1391 Info

Line 9
Item: High wattage incandescent lighting retrofit.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing high wattage incandescent lighting with energy efficient retrofit.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy use of the installation by replacing existing high wattage incandescent lighting with energy efficient replacement technology. It will also reduce electrical demand.

B. Requirement: Existing lighting is inefficient and has been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing lighting consumes excess energy compared to other available technologies that can reduce energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(Δ) Wattage Saved
Wattage saved by replacement of high wattage incandescent with fluorescent or metal halide (old watts-new watts).

(FAP) Fraction of Area on Perimeter
Fraction of lighted area within 15 ft of the perimeter of the building. Default value is 0.7.

(COP) A/C COP
Coefficient of performance: energy-efficiency of air conditioning. Default value is 3.

(NAGeff) NAG Heating Efficiency

(%NAG) Percent of Facility Heated by NAG

(Oeff) Oil Heating Efficiency

(%O) Percent of Facility Heated by Oil

(Ceff) Coal Heating Efficiency

(%C) Percent of Facility Heated by Coal

(otheff) Other Heating Efficiency

(%oth) Percent of Facility Heated by Other

Formulas

Construction Cost ($) = Σ(# * $U)

Demand Savings (KW) = (Σ # * ΔW) * d/1,000

Demand Cost Savings ($/year) = Demand Savings * $D

Lighting Electrical Energy Saved (MBtu/year) = Demand Savings * Hrs * (3.412/1,000)

Lighting Electrical Cost Savings ($/year) = Ltg Elec En Svd * $E

Cooling Energy Savings (MBtu/year) = (Ltg Elec En Svd * 0.27)/COP
where: 0.27 is the lighting cooling fraction

Cooling Cost Savings ($/year) = Cooling Energy Savings * $E

Heating Energy Saved (MBtu/year) = -(Ltg Elec En Svgs * 0.3 * FAP
where 0.3 is the lighting heating fraction

Heating Cost Savings ($/year) = Heating Energy Saved * [($NAG * (%NAG/%NAGeff)) + ($O * (%O/Oeff)) + ($C * (%C/Ceff)) + ($oth * (%oth/otheff))]

T-5 Fluorescent Lighting

Background

T5 fluorescents are 5/8-in. diameter fluorescent tubes. They are more efficient than HID systems, and offer lower lumen depreciation rates, better dimming options, instant start-up and restrike, better color rendition, and less glare. Although some HID systems offer similar instant start-up and restrike, it is mostly at the sacrifice of rated life.

Expected Life

The rated life of some T5s is about 15,000 hours, compared with 20,000 hours for a typical metal halide. However, since the metal halide lamp tends to depreciate significantly in brightness towards the end of its life, it tends to be considered unusable well before its full rated life. The T5 has a much lower lumen depreciation rate (as low as 5 percent), enabling it to fulfill its total life expectancy.

Energy Use

Linear T5 fluorescent fixtures have an efficacy of 100-105 lumens/watt, compared to 40-70 to 70-90 lumens/watt for most metal halides, and even lower values for other fluorescents and incandescents. A retrofit at a manufacturing plant in Massachusetts replaced 160 metal halide fixtures with twin T5s and electronic ballasts. The retrofit yielded a 50 percent cut in electricity use, along with the benefits of better color rendition, instant-on switching, and instant restrike. The electricity savings paid for the retrofit in 2.5 years.

Ballasts

Electronic ballasts are recommended for T5s. They improve the efficiency of the lamp, reduce flicker, and the newer types allow low temperature starts and frequent switching without reducing lamp life.

Light Quality

T5s offer a greater amount of light in the blue spectrum, which is more readily perceived by the human eye than other wavelengths. Thus, T5 lamps put out more *pupil lumens*, or easily perceivable lumens, than their conventional efficacy rating indicates. The color rendering index (CRI) for T5s is 10 to 90 percent higher than for HID lamps.

Applications

T5s are generally more efficient than HIDs in medium and high-bay applications. However, HID technology still dominates in applications using lamps of 1000W or more, outdoor flood lamps for sports stadiums, sub-zero temperatures, and accent or display lighting.

References

E Source web site: http://www.esource.com

General Services Administration Lighting web site: http://www.fedlightgov.com/

Defense Logistics Agency (DLA) web site, "Lighting" includes descriptions of the latest available lighting technology and products: dscp103.dscp.dla.mil/gi/general/light1.htm

National Electrical Manufacturers Association Lighting Systems Division, "Application Note: Wiring Requirements for 2G11 Based T-5 Fluorescent Twin Lamps With Instant-Start Ballasts," LDS 2B-1999, http://www.nema.org/products/div2/eolupdate.html

Fluorescent Lamps," Pacific Gas and Electric Energy Website, *Information*, http://www.pge.com/customer_services/other/pec/inftoc/fluoresc.html

Jim Rogers and Ira Krepchin, *New High-Intensity Fluorescent Lights Outshine Their HID Competitors*, ER-00-1 (January 2000), Esource website, http://www.esource.com/

DD 1391 Info

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Retrofit existing HID or incandescent fixtures with T5 fluorescent lamps.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy consumption of the installation by installing more efficient lighting equipment.

B. Requirement: Existing lighting fixtures have been in place for over 3 years, and the replacement project has a payback of 3 years.

C. Current Situation: Existing systems consume excess electrical power compared to other available technologies that can extend equipment life while reducing energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential saving in energy dollars, in reduced maintenance costs, and may not meet Federally mandated energy reduction goals.

Variables

(Δ) Wattage Saved
Wattage saved by replacement of incandescent or HID with T5 fluorescent lighting (old watts-new watts).

(FAP) Fraction of Area on Perimeter
Fraction of lighted area within 15 ft of the perimeter of the building. Default value is 0.7.

(COP) A/C COP
Coefficient of performance: energy-efficiency of air conditioning. Default value is 3.

(NAGeff) NAG Heating Efficiency

(%NAG) Percent of Facility Heated by NAG

(Oeff) Oil Heating Efficiency

(%O) Percent of Facility Heated by Oil

(Ceff) Coal Heating Efficiency

(%C) Percent of Facility Heated by Coal

(otheff) Other Heating Efficiency

(%oth) Percent of Facility Heated by Other

Formulas

Construction Cost ($) = Σ(# * $U)

Demand Savings (KW) = (Σ # * ΔW) * d/1,000

Demand Cost Savings ($/year) = Demand Savings * $D

Lighting Electrical Energy Saved (MBtu/year) = Demand Savings * Hrs * (3.412/1,000)

Lighting Electrical Cost Savings ($/year) = Electrical Energy Saved * $E

Cooling Energy Savings (MBtu/year) = (Ltg Elec En Svg * 0.27)/COP
Where 0.27 is the lighting cooling fraction

Cooling Cost Savings ($/year) = Cooling Energy Savings * $E

Heating Energy Saved (MBtu/year) = (Ltg Elec En Svgs * 0.3 * FAP)
where 0.3 is the lighting heating fraction

Heating Cost Savings ($/year) = Heating Energy Saved * [($NAG * (%NAG/%NAGeff)) + ($O * (%O/Oeff)) + ($C * (%C/Ceff)) + ($oth * (%oth/otheff))]

Energy Efficient Motors

Background

Motor driven systems consume an estimated 40 to 60 percent of the electrical energy in a typical building. At the same time, motors use four to ten times their purchase price in electric energy costs each year. Improving motor efficiency can save a substantial amount of energy. Advances in electric motor designs and materials have led to higher motor efficiencies. This ECO examines the energy savings attributed to replacing existing motors with high efficiency units.

Motor Size Considerations

Motors are often oversized for their applications. Consider downsizing when replacing a standard motor with a high efficiency motor.

Operating Characteristics

An underloaded high efficiency motor will rotate faster, which may negate the energy savings. It may be necessary to modify the pump impeller or fan blade to achieve design performance of the equipment at lower energy use. If feasible, consider replacing the fan or pump concurrently with motor replacement, to best achieve system design parameters. Energy efficient motors often run cooler because of their lower losses; they are also likely to tolerate heat better. This may result in a longer life or lower maintenance costs than conventional motors. This value may be entered by the user and included in the LCCA.

Energy Analysis

The electrical energy saved by replacing a motor with a high efficiency motor is due to the difference in efficiencies. The difference in horsepower (HP) ratings of the existing and replacement motors multiplied by the number of hours of operation results in the savings in electrical consumption for one motor. The demand saving is also based on the difference in the motors' size. The diversity factor used for calculating electrical demand savings refers to the number of motors running at any one time.

High Efficiency Motor References

E Source web site: http://www.esource.com

The Motor Challenge Information Clearinghouse, P.O. Box 43171, Olympia, WA 98504-3171

DD1391 Info

Line 9
Item: High efficiency motor.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing motors with high efficiency motors.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy use of the installation by replacing existing motors with high efficiency motors. It will also reduce electrical demand.

B. Requirement: Existing motors are inefficient and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing motors consume excess energy compared to other available technologies that can reduce energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(HPold) HP Rating of Existing Motor

(HPnew) HP Rating of Replacement Motor

(ΔHP) Change in HP Rating
HP rating of existing motor – HP rating of replacement motor.

(ΔMaint) Change in Annual Maintenance Cost
Annual maintenance cost savings as a result of this retrofit ($/year).

Formulas

Construction Cost ($) = Σ (# * ($U + $L))

Energy Saved (MBtu/year) = Σ(# * ΔHP * Hrs) * 0.746 * 3.412/1000

Energy Cost Savings ($/year) = Energy Saved * $E

Demand Savings (KW) = d * [Σ(# * ΔHP)] * 0.746

Demand Cost Savings ($) = Demand Savings * $D

Refrigeration Liquid Pressure Amplifiers

Background

The liquid pressure amplifier (LPA) refrigerant pump is a simple, reliable means of pressurizing liquid refrigerant to avoid flash evaporation in the liquid line. This addition allows the minimum head pressure control to be adjusted to allow lower compressor discharge pressures at lower ambient temperatures. It increases the capacity and efficiency of new and existing refrigeration and air conditioning systems. Typical compressor energy savings of 10 to 30 percent and typical paybacks of 1 to 3 years have been realized in field tests.

Other Benefits

Lowering the minimum condenser pressure constraint allows the compressor to operate with a reduced duty fraction, lower internal temperatures and lower stress. Other benefits are less noise, vibration, and wear. Utilities sometimes offer demand-side management incentives for LPA installation to commercial and industrial customers.

Application

Climates with wide variations in ambient temperature in the periods when the refrigeration equipment must operate generally favor LPA retrofits. An understanding of the savings mechanism and how equipment, load, and climate characteristics affect savings is essential to proper application of the technology. Staff must be properly trained in the operation and maintenance of floating-head controls and the maintenance program should be modified. An application checklist is contained in the Federal Technology Alert listed under references.

Energy Analysis

The electrical savings due to installation of an LPA is due to the increased efficiency of the compressor. The increase in efficiency times the size of the compressor, the KW/ton and a diversity factor gives the electrical demand savings. Energy savings are obtained by calculating annual cooling hours from the cooling degree days, summer design temperature, and cooling temperature, and then by multiplying this by demand savings. The diversity factor used for calculating electrical demand savings refers to the number of compressors running at any one time.

References

Federal Technology Alert: "Liquid Refrigerant Pumping," http://www.pnl.gov/fta/7_lrp.htm

E Source: *Electronic Encyclopedia*, Release VII (September 1992 – June 1999).

DD1391 Info

Line 9
Item: Liquid Pressure Amplifier (LPA).

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Install liquid pressure amplifier(s).

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy use of the installation by reducing energy consumed by refrigeration and air conditioning compressors. It will also reduce electrical demand and the amount of CFCs required.

B. Requirement: Existing refrigeration and air conditioning compressors consume excess energy and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing chillers consume excess energy compared to other available technologies that can reduce energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(Δ HP) Difference in Horsepower
Old HP – new HP.

(CDD) Cooling Degree Days
The sum of the difference between the average daily temperature and 65 °F (cooling required) over a year.

($\Delta\eta$) Change in Efficiency
Improvement in efficiency expressed in %.

(size) Chiller Size
Chilling capacity (tons).

(ref) Refrigeration
Measured in KW/ton.

(Tsum) Summer Design Temperature
Outdoor temperature for which cooling system is designed (°F).

(Tcool) Cooling Temperature
Desired indoor cooling temperature (°F).

(ΔT) Temperature Difference
Tsum – Tcool (°F).

Formulas

Construction Cost ($) = Σ(# * $U)

Energy Saved (MBtu/yr) = (24 * CDD) / ΔT * (Summer Demand Savings * 3.412)

Energy Cost Savings ($/year) = Energy Saved * $E

Summer Demand Savings (KW) = Σ (# * Δη * size) * ref * d

Demand Cost Savings ($/year) = Summer Demand Savings * $SD

High Efficiency Chillers

Background

Large chillers located in central energy plants use a significant amount of electrical energy. This ECO calculates the savings resulting from the replacement of old electric chillers with new, higher efficiency electric chillers that are non-CFC based. Selecting replacement chillers requires a balance of first cost, operating costs and refrigeration choices.

Chiller Size Considerations

Chillers are often oversized for their application. Consider downsizing when replacing a standard chiller with a high efficiency chiller. Perform other building energy retrofits such as reducing lighting and plug loads before replacing chillers. This will reduce the cooling load and enable replacement with a smaller chiller. Include HVAC system optimization as part of the chiller replacement project to improve overall building performance and life cycle cost savings.

Operating Characteristics

Most cooling systems are less efficient at low loads. Smaller chillers that closely match the load should be installed. Reducing the size of the chiller may allow reduction of the size of auxiliary components. The condenser water pump, chilled water pump, cooling tower fan and air-handling unit combined use about as much energy as the chiller. Where more than one chiller is necessary, select machines of different sizes. The cooling plant should serve year-round cooling loads. This means that part-load efficiency is a critical element of the design strategy.

Energy Analysis

The electrical consumption saved by replacing a chiller with a high efficiency chiller is due to the difference in efficiencies. The difference between old and new KW/ton times the size of the compressor, and a diversity factor gives the electrical demand savings. Energy savings are obtained by calculating annual cooling hours from the cooling degree days, summer design temperature and cooling temperature and multiplying this by demand savings. The diversity factor used for calculating electrical demand savings refers to the number of chillers running at any one time.

High Efficiency Chiller References

E Source: Department of Energy (DOE) Federal Energy Management Program (FEMP) technical resources web site includes information about energy-saving measures and strategies for buildings, HVAC and high efficiency chillers: http://www.eren.doe.gov/femp/techassist/grn_resources.html

E Source: *Electronic Encyclopedia*, Release VII (September 1992 – June 1999).

DD1391 Info

Line 9
Item: High efficiency chillers.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing chillers with high efficiency chillers.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy use of the installation by replacing existing chillers with high efficiency chillers. It will also reduce electrical demand and the amount of CFCs required.

B. Requirement: Existing chillers are inefficient and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing chillers consume excess energy compared to other available technologies that can reduce energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(CDD) Cooling Degree Days
Number of degree days that cooling is required based on 75 °F.

(Tsum) Summer Design Temperature
Outdoor temperature for which cooling system is designed (°F).

(Tcool) Cooling Temperature
Desired indoor cooling temperature (°F).

(ΔT) Temperature Difference
Tsum – Tcool (°F).

(ref) Refrigeration
Amount of refrigeration provided by a chiller (KW/ton).

(Δref) Change in Refrigeration
Old refrigeration – new refrigeration (KW/ton).

(size) Replacement Chiller size
Chilling capacity (tons).

Formulas

Construction Cost ($) = Σ(# * $U)

Energy Saved (MBtu/yr) = (24 * CDD) / ΔT * (Summer Demand Savings * 3.412)

Energy Cost Savings ($/year) = Energy Saved * $E

Summer Demand Savings (KW) = Σ (# * Δref* size) * ref * d

Demand Cost Savings ($/year) = Summer Demand Savings * $SD

High Efficiency Gas Boilers

Background

Buildings isolated from an installation's central heating network use about half of the Army's heating energy. Replacing the older boilers in these buildings with new high efficiency boilers can reduce fuel usage, cost and harmful emissions. Buildings best suited for conversion are those that have gas-fired hot water boilers in the size range of 0.5 to 1.5 MBtu/hr.

Boiler Size Considerations

Boilers are often oversized for their application. Consider downsizing when replacing a standard boiler with a high efficiency boiler. Perform other energy retrofits such as window replacement and envelope insulation before replacing boilers. This will reduce the heating load and enable replacement with a smaller boiler. Include HVAC system optimization as part of the boiler replacement project to improve overall building performance and life cycle cost savings.

Operating Characteristics

Boiler size is generally based on design or maximum load. During most of the heating season, boilers will operate at part load, resulting in significant cyclic losses. A heating system comprised of several independently operating modular units is more efficient than one large boiler. Each modular boiler will typically operate at its rated capacity, with additional units meeting increasing demand for heating.

Energy Analysis

The natural gas consumption saved by replacing an existing boiler with a high efficiency boiler is due to the difference in efficiencies. The increase in efficiency times the size of the boiler multiplied by the full load heating results in the savings in gas consumption for one boiler. Full load heating is determined from the winter design temperature, heating temperature and heating degree days based on 65 °F.

High Efficiency Gas Boiler References

Architect's and Engineer's Guide to Energy Conservation in Existing Buildings, Volume 2 – Energy Conservation Opportunities (U.S. Department of Energy, April 1990).

E Source: Department of Energy (DOE) Federal Energy Management Program (FEMP) technical resources web site includes information about energy-saving measures and strategies for buildings, HVAC and high efficiency chillers: http://www.eren.doe.gov/femp/techassist/grn_resources.html

E Source: *Electronic Encyclopedia*, Release VII (September 1992 – June 1999).

Yusaf A. Shikari, Mark E. Richards, and William R. Taylor, *Energy Technology Screening Criteria*, CERL Technical Report (TR) 98/111/ADA359609 (CERL, August 1998).

DD1391 Info

Line 9
Item: High efficiency gas boilers.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Replace existing gas boilers with high efficiency gas boilers.

Line 11
REQUIREMENT:

A. Project: This project will reduce the natural gas consumption of the installation by replacing existing boilers with high efficiency gas boilers.

B. Requirement: Existing boilers are inefficient and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing boilers consume excess natural gas compared to other available technologies that can reduce energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(eff) Efficiency of Old Boiler

(Reff) Efficiency of Replacement Boiler

(size) Size of Replacement Boiler
Measured in MBtu/hour.

(Twin) Winter Design Temperature
Measured in °F.

(Theat) Heating Temperature
Measured in °F.

(HDD) Heating Degree Days
The sum of the difference between the average daily temperature and 65 °F (heating required) over a year.

Formulas

Construction Cost ($/year) = Σ(# * $)

Energy Saved (MBtu/yr) = Σ(# * size * ((100/eff) – (100/Reff))) * (24 * HDD) / (Theat - Twin)

Energy Cost Savings ($/year) = Energy Saved * $G

Direct Digital Controls

Background

Direct Digital Control (DDC) Systems have a significant potential for application in Army buildings. The paybacks are in the medium range and the energy savings large. DDC should be considered to replace existing pneumatic control systems. This ECO was analyzed for six building types. Each building type must be calculated separately because of the number of assumptions required. Energy use factors were developed using square footage mixes and percentages from audits conducted at Fort Hood, Fort Carson, and Fort Belvoir.

Energy Analysis

This analysis assumes that heating energy use is reduced by 15 percent, cooling season electrical use is reduced by 15 percent, and noncooling season electrical use is reduced by 8 percent. Table 2 lists energy use factors contained in the PA program. The units for heating load are Btu/sf/HDD. The units for cooling season and non-cooling season electrical load are KWh/sf. These values, as well as the percentage savings, can be changed by the user. Note that this algorithm for energy controls should be used for initial scoping of projects. A more detailed analysis of actual digital controls, considering specific strategies, equipment being controlled and building types, must be done to justify a project.

References

E Source web site: http://www.esource.com

Table 2. Building energy use factors for DDC.

Building	Heating Load	Clg Season Elec	Non-Clg Season Elec
Admin	18.97	0.0512	0.0215
Barracks	26.27	0.001275	0.0215
Community	22.97	0.0684	0.0682
Training	18.97	0.0512	0.0215
Medical	24.31	0.0557	0.0353
R&D	18.97	0.0512	0.0215

DD1391 Info

Line 9
Item: Direct Digital Controls (DDC).

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Retrofit existing controls with direct digital controls.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy use of the installation by replacing existing controls with direct digital controls.

B. Requirement: Existing controls are ineffectual and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing controls allow HVAC and other systems to consume excess energy compared to other available control technologies that can reduce energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(#b) Number of Buildings
Number of buildings of a particular type. (Admin, Barracks, Community, Training, Medical, R&D)

(sf) Square Footage of Buildings
Area of buildings measured in square feet.

(#points) Number of Monitoring and Control Points
Average number of digital control points per building.

($p) Cost per Point
Labor and material cost to install one point.

(heat) Heating Load
Heating load measured in Btu/sf/HDD.

(Ecool) Cooling Season Electrical Load
Cooling season electrical load measured in KWh/sf.

(Eheat) Heating Season Electrical Load
Heating season electrical load for all buildings of a particular type, measured in KWh/sf.

(ΔEheat) Heating Load Energy Savings
Measured as a decimal percentage.

(ΔEcool) Cooling Load Energy Savings
Measured as a decimal percentage.

(ΔE) Baseline Electrical Load Energy Savings
Measured as a decimal percentage.

(HDD) Heating Degree Days
The sum of the difference between the average daily temperature and 65 °F (heating required) over a year.

(Lclg) Length of Cooling Season
Number of days that air conditioning is required.

(NAGeff) NAG Heating Efficiency

(%NAG) Percent of Facility Heated by NAG

(Oeff) Oil Heating Efficiency

(%O) Percent of Facility Heated by Oil

(Ceff) Coal Heating Efficiency

(%C) Percent of Facility Heated by Coal

(otheff) Other Heating Efficiency

(%oth) Percent of Facility Heated by Other

Formulas

Construction Cost ($) = $p * #b * #points

Heating Energy Saved (MBtu/year) = (heat * sf) * (ΔEheat/1,000,000) * HDD

Heating Cost Savings ($/year) = Heating Energy Saved * [($NAG * (%NAG/%NAGeff)) + ($O * (%O/Oeff)) + ($C * (%C/Ceff)) + ($oth * (%oth/otheff))]

Electrical Energy Saved (MBtu/year) = {(ΔEcool * Ecool * sf * Lclg) + [(ΔE * Eheat * sf * (365 – Lclg)]} * 3.412/1000

Electrical Energy Cost Savings ($/year) = Electrical Energy Saved * $E

Adjustable Speed Drives

Background

Advances in electric motor control designs have resulted in the adjustable speed drive (ASD). The ASD can be retrofitted to existing motors and allows the motor to adjust to meet the load. This ECO specifically examines the energy savings attributed to retrofitting existing ventilation motors with ASD controllers.

ASD Size Considerations

For the purpose of this ECO, small motors range from 1 to 10 HP, medium motors range from 10 to 20 HP, and large motors are over 20 HP.

Operating Characteristics

This ECO assumes that existing ventilation fans operate at 100 percent of rated flow during all operating hours. The load profile shown in Table 3 was assumed for ventilation fan motors fitted with ASDs.

Table 3. Load profile assumed for ventilation fan motors fitted with ASDs.

% Flow	% Time	Weighted Flow
53	5	0.0265
53	5	0.0265
52	4	0.0208
50	4	0.0200
48	4	0.0192
52	4	0.0208
63	4	0.022
77	4	0.0280
91	4	0.0364
97	4	0.0388

% Flow	% Time	Weighted Flow
97	4	0.0388
95	4	0.0380
95	4	0.0380
98	4	0.0392
100	4	0.0400
97	4	0.0388
88	4	0.0352
78	4	0.031
70	4	0.0280
66	4	0.0264
65	4	0.0260
63	4	0.0252
60	5	0.0300
56	5	0.0280

Energy Analysis

The following algorithms were used to determine energy savings:

Large:	Original:	HP = (-1.32765 + 0.000921 * Flow)
	ASD Retro:	HP = (-13.1571 + (0.001291 * (Flow * 0.725))
Medium:	Original:	HP = (-1.23288 + 0.001055 * Flow)
	ASD Retro:	HP = (-8.59041 + (0.001502 * (Flow * 0.725))
Small:	Original:	HP = (-0.13889 + 0.000705 * Flow)
	ASD Retro:	HP = (-3.3375 + (0.001131 * (Flow * 0.725))

System flow was the rated flow for existing systems and the weighted flow, obtained from the table, for systems with an ASD:

MWH = % time x hrs operated x 0.746 x HP

References

E Source web site: http://www.esource.com

DD1391 Info

Line 9
Item: Ventilation motor adjustable speed drive.

Line 10
DESCRIPTION OF PROPOSED CONSTRUCTION:
Retrofit existing ventilation motors with adjustable speed drives.

Line 11
REQUIREMENT:

A. Project: This project will reduce the electrical energy use of the installation by retrofitting existing ventilation motors with adjustable speed drives. It will also reduce electrical demand.

B. Requirement: Existing ventilation motors are inefficient and have been in service for at least 3 years. The EPAct of 1992 requires execution of projects with a payback under 10 years.

C. Current Situation: Existing ventilation motors consume excess energy compared to other available technologies that can reduce energy consumption.

D. Impact if not Provided: The installation will continue to sacrifice potential energy savings, and may not meet Federally mandated energy reduction goals.

Variables

(#) Number of ASDs
Number of ASDs to install on a motor of particular size (small, medium, or large HP).

($) Installed Cost
Cost of unit plus labor cost for installation of new ASD of a particular size.

(Hrs) Annual Hours of Operation
For a motor of a particular size.

(flow) Rated Flow
Rated flow of a system of a particular size, measured in CFM (S=small, M=medium, L=large).

Formulas

Construction Cost ($) = Σ(# * $)

Energy Saved (MBtu/year) = 0.746 * 3.412/1000 *
[{(-0.13889 + 0.007.05 * flowS) –
[-3.3375 + 0.001131 * (flowS * 0.725)]} * HrsS +
{(-0.23288 + 0.001055 * flowM) –
[-8.59041 + 0.001502 * (flowM * 0.725)]} * HrsM +
{(-1.32765 + 0.00921 * flowL) –
[-13.1571 + 0.001291 * (flowL * 0.725)]} * HrsL]

Energy Cost Savings ($) = Energy Saved * $E

6 Life Cycle Cost Analysis

Project Assistant is configured to prepare the Life Cycle Cost Analysis (LCCA) required to support energy and water conservation projects. In addition to the standard ECIP LCCA, PA will evaluate projects to determine the financial viability of Energy Saving Performance Contracts (ESPC).

LCCA Form

Refer to the Life Cycle Cost Analysis Summary, Energy Conservation Investment Program (ECIP) and Energy Saving Performance Contract (ESPC) forms in Appendix C for the following explanation. All of the information shown in the LCCA report is linked to or calculated from data input through other PA windows.

Project Information

The following project information is found in the heading of both LCCA forms.

Location
Linked to Installation window.

Project Title
Uses title of ECO/WCO from ECO window.

Analysis Date
Automatic.

Region No.
Linked to installation name in Installation window. Each region has a unique set of discount factors used in preparing LCCAs. The following list shows the states in each region:

Census Region 1
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.

Census Region 2
Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.

Census Region 3
Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.

Census Region 4
Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

Census Region 5
U.S. average.

Fiscal Year
Linked to fiscal year input in LCCA window.

Economic Life
Linked to ECO/WCO, based on ECIP criteria.

Resource Efficient Washers
15 years.

Faucet Aerators
10 years.

Shower Heads
10 years.

Flush Valves
10 years.

Lighting ECOs
15 years.

Energy Efficient Motors
20 years.

Refrigeration LPAs
20 years.

High Efficiency Chillers
20 years.

High Efficiency Gas Boilers
20 years.

Direct Digital Controls
10 years.

Adjustable Speed Drives
20 years.

Preparer
User input; technical POC for the project.

Contractor's Economic Assumptions (ESPC Analysis Only)

The information in this section allows PA to calculate the economic viability of ESPC proposals/projects. The following rates should be obtained from the interested ESPC firm. If a specific firm is not yet identified, rates may be available from the U.S. Department of Energy or from rates in existing ESPC contracts.

Private Borrowing Rate
Interest rate ESPC contractor must pay to borrow money for this project, typically about 7 percent.

Risk Premium
Guarantees the contractor will make money.

Tax Rate on Profits
Tax rate the ESPC contractor pays.

ESPC Discount Rate
This rate is used to obtain the discount factors used in the LCCA and is calculated using the formula:

$$\frac{\text{Private Borrowing Rate} + \text{Risk Premium}}{(1 - \text{Tax Rate on Profits})}$$

Investment Costs

Construction Costs
PA adds up all values for material and labor costs.

Site Inspection & Overhead
The default value is 6 percent of construction costs.

Design Cost
The default value is 6 percent of construction costs.

Total Cost
The sum of construction, SIOH and design costs.

Salvage Value of Existing Equipment
User input.

Public Utility Company Rebate
User input.

Total Investment
Total cost minus salvage value and rebate.

Energy Savings (+) or Cost (-)

Date of NISTIR 4942 Used for Discount Factors

The ECIP discount factors are obtained from NISTIR 4942, which is published in April of each year.

Energy Source

List of possible fuels impacted by the project.

Cost

Unit cost of each fuel; default value from the ECO window.

Savings

Annual increase or decrease in energy use as a result of this project, calculated by the PA algorithm.

Annual $ Cost or Savings

Annual increase or decrease in the cost of energy as a result of this project. Equal to ($/MBTU)*(MBTU/YR).

Discount Factor

From Table Ba NISTIR 4942 for ECIP projects, calculated below for ESPC projects.

Discounted Savings

Annual cost savings x discount factor.

ESPC Energy Discount Factor = $\sum i^n \Big/ \left(\frac{1}{1+d}\right)^n$

where:

i = the fuel escalation factor for a specific year (from Table Ca in the NISTIR 4942)
d = the ESPC discount rate (calculated on the previous page)
n = the year of energy usage.

Non-Energy Annual Recurring Savings (+) or Cost (-)

Annual Recurring (+/-)

List item.

Savings (+) or Cost (-)

Annual cost or savings.

Discount Factor

From Table A-2 in NISTIR 4942 for ECIP projects, calculated below for ESPC projects.

Discounted Savings/Cost

Annual savings or cost x discount factor.

ESPC Non-Energy Annual Recurring Discount Factor = $\dfrac{(1+d)^N - 1}{d(1+d)^N}$

where:

d = the ESPC discount rate (from the previous page)
N = the economic life of the project.

Non-Energy Non-Recurring Savings (+) or Cost (-)

Item
List item.

Savings (+) or Cost (-)
Annual cost or savings.

Year of Occurrence
Year in which savings or cost will be realized.

Discount Factor
From Table A-2 in NISTIR 4942 for ECIP projects, calculate below for ESPC projects.

Discounted Savings/Cost
Annual savings or cost x discount factor.

ESPC Non-Energy Non-Recurring Discount Factor = $\dfrac{1}{(1+d)^n}$

where:

d = the ESPC discount rate
n = the year that savings are realized.

First Year Dollar Savings =

total annual energy savings + annual recurring non-energy savings + (non-recurring savings/economic life of the project)

Simple Payback = total investment/first year dollar savings

Total Net Discounted Savings =

total energy discounted savings + total non-energy discounted savings

Savings to Investment Ratio (SIR) = total net discounted savings/total investment

7 Conclusions and Recommendations

This work has provided documentation for the Energy Manager Project Assistant, to help energy managers create correct, complete DD1391 energy project calculations and narratives.

The Energy Manager Project Assistant software program provides a standard template for DD1391 energy project calculations and narratives. This program allows energy managers to quickly and accurately develop information for DD1391 project documentation and supporting economic analyses using standardized methodology. The user provides specific site information to the analysis and adds narrative to describe the project at their installation. This new analysis tool saves time and ensures consistency in calculating energy and dollar savings by incorporating common assumptions and standardized algorithms.

Generation of a traditional life cycle cost analysis (LCCA) form used for direct-funded projects can help the user request/justify government funding. A second LCCA form allows the user to evaluate the energy savings and viability of alternatively financed proposals such as those developed under Energy Savings Performance Contracts (ESPCs) or utility partnerships.

References

Bullough, John, Kun Michelle Huang, and Kathryn Conway, *Optimizing the Design and Use of Light-Emitting Diodes for Visually Critical Applications in Transportation and Architecture* (Lighting Research Center, 1998).

Defense Logistics Agency (DLA) web site, "Lighting" includes descriptions of the latest available lighting technology and products: dscp103.dscp.dla.mil/gi/general/light1.htm

E Source: *Electronic Encyclopedia*, Release VII (September 1992 – June 1999).

E Source web site: http://www.esource.com

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"Fluorescent Lamps" Pacific Gas and Electric Energy Website, "Information," http://www.pge.com/customer_services/other/pec/inftoc/fluoresc.html

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List of Abbreviations and Acronyms

ASD	Adjustable Speed Drive
DDC	Direct Digital Control
ECIP	Energy Conservation Investment Program
ECO	Energy Conservation Opportunity
EPAct	Energy Policy Act of 1992
ESPC	Energy Saving Performance Contract
HVAC	Heating, Ventilating, and Air-Conditioning
LED	Light Emitting Diodes
LCCA	Life Cycle Coast Analysis
LPA	Liquid Pressure Amplifier
MACOM	(Army) Major Command
O&M	Operations and Maintenance
PA	Project Assistant
R&D	Research and Development
REEP	Renewables and Energy Efficiency Planning (Program)

Appendix A: List of Military Installations in Project Assistant

Table A1. DOD installations included in Project Assistant.

Army
Aberdeen Proving Ground
Anniston Army Depot
Blue Grass Army Depot
Carlisle Barracks
Corpus Christi Army Depot
Detroit Arsenal
Dugway Proving Ground
Fort A.P. Hill
Fort Belvoir
Fort Benning
Fort Bliss
Fort Bragg
Fort Buchanan
Fort Campbell
Fort Carson
Fort Detrick
Fort Devens Res. Forces Trng
Fort Dix Reserve Forces Trng
Fort Drum
Fort Eustis
Fort Gordon
Fort Greely
Fort Hamilton
Fort Hood
Fort Huachuca
Fort Irwin
Fort Jackson
Fort Knox
Fort Leavenworth
Fort Lee
Fort Leonard Wood
Fort Lewis
Fort McCoy
Fort McPherson
Fort Meade
Fort Monmouth
Fort Monroe
Fort Myer
Fort Polk
Fort Richardson
Fort Riley
Fort Rucker
Fort Sam Houston
Fort Shafter
Fort Sill
Fort Stewart
Fort Wainwright
Hawthorne Army Depot
Holston Aap
Hunter Aaf
Iowa Aap
Lake City Aap
Letterkenny Army Depot
Lima Tank Plant
Lone Star Aap
Mcalester Aap
Milan Aap
Natick R&D Engineering Center
Newport Chemical Depot
Picatinny Arsenal
Pine Bluff Arsenal
Presidio Of Monterey
Pueblo Chemical Depot
Radford Aap
Red River Army Depot
Redstone Arsenal
Rock Island Arsenal
Sierra Army Depot
Sunny Point Military Ocean Terminal
Tobyhanna Army Depot
Tooele Army Depot
Umatilla Chemical Depot
Walter Reed
Watervliet Arsenal
West Point Mil Acad
White Sands Missile Range
Yuma Proving Ground

Air Force
AF Academy
Altus AFB
Andrews AFB
Arnold
Barksdale AFB
Beale AFB
Bolling AFB
Brooks
Buckley ANG Base
Canon AFB
Carswell
Charleston AFB
Columbus AFB
Davis Monthan AFB
Dobbins
Dover AFB
Dyess AFB
Edwards
Eglin
Ellsworth AFB
F.E. Warren AFB
Fairchild AFB
Goodfellow AFB
Grand Forks AFB
Grissom ARB
Gunter AFB

Hanscom
Hickam
Hill
Holloman AFB
Homestead
Hurlburt Field
Keesler AFB
Kelly
Kirtland
Lackland AFB
Langley AFB
Laughlin AFB
Little Rock AFB
Los Angeles
Luke AFB
Malmstrom AFB
March ARB
Maxwell AFB
Mcchord AFB
Mcclellan
Mcconnell AFB
Mcguire AFB
Minot AFB
Moody AFB
Mountain Home
Nellis AFB
Offutt AFB
Onizuka AFS
Patrick AFB
Peterson AFB
Pope AFB
Randolph AFB
Reese AFB
Robins
Schriever AFB
Scott AFB
Seymour Johnson AFB
Shaw AFB
Sheppard AFB
Tinker
Travis AFB
Tyndall AFB
Vance AFB
Vandenberg AFB
Westover ARB
Whiteman
Wright-Patterson AFB

Navy
Adak
Alameda NARF
Albany
Annapolis
Beaufort/Parris Is
Bethpage
Brunswick
Charleston
Cherry Point
China Lake
Colts Neck
Corpus Christi
Crane NWSC
Dahlgren
Dallas
Fallon
Great Lakes
Gulfport
Indian Head
Indianapolis
Jacksonville
Key West
Kings Bay
Lakehurst
Lemoore
Los Angeles Area
Louisville
Mare Island
Mechanicsburg
Memphis
Meridian NAS
Miramar
Moffett Field
New Orleans
NY City
New London
Newport
Norfolk
Oakland
Oakland Hospital
Orlando
Patuxent River
Pearl Harbor
Pensacola
Philadelphia
Port Hueneme/Pt. Ma
San Diego
San Francisco
Seattle
Trenton
Warminster
Washington D.C.
Whidbey Is.
Yorktown

Marines
Barstow
Camp Lejeune
Camp Pendleton
Quantico
Twentynine Palms
Yuma

Appendix B: List of Variables

Utility and Fuel Rates

($E) Electric in ($/KWh)

($D) Annualized Demand in ($/KW)

($SD) Summer Demand in ($/KW)

($NAG) Natural Gas in ($/MBtu)

($O) Oil in ($/MBtu)

($C) Coal ($/MBtu)

($oth) Other ($/MBtu)

($W) Water ($/Kgal)

($S) Sewage Treatment ($/Kgal)

General

(#) Number of Units To Replace (Each)

($U) Cost of Unit ($)

($L) Labor Cost ($)

(Hrs) Annual Hours of Operation (Hours)

($maint) Change in Annual Maintenance Cost ($/year)

(d) Diversity Factor (%)

(e) Economic life (Yrs)

Water

(Wuse) Typical Water Consumption/Use (Gallons/Use)

(HWuse) Hot Water Consumption/Use (Gallons of Hot Water/Use)

(ΔW) Water Saved/Use (Gallons of Water/Use)

(ΔHW) Hot Water Saved/Use (Gallons of Hot Water/Use)

(p) Persons/Unit

(use) Uses/Day/Person

(Erate) Electrical Pumping Energy Rate (MBtu/Kgal)

(Tdiff) Hot Water Temperature Differential (°F)

(therm) Thermal Capacity of Water (Btu-°F-gal)

(NAGeff) NAG Water Heater Efficiency (%)

(%NAG) Percent of Water Heated by NAG (%)

(Eeff) Electric Water Heater Efficiency (%)

(%E) Percent of Water Heated by Electricity (%)

(PPGeff) PPG Water Heater Efficiency (%)

(%PPG) Percent of Water Heated by PPG (%)

Lighting

(FAP) Fraction of Area on Perimeter (%)

(COP) A/C COP

(ΔW) Wattage Saved (watts/unit)

(NAGeff) NAG Heating Efficiency (%)

(%NAG) Percent of Facility Heated by NAG (%)

(Oeff) Oil Heating Efficiency (%)

(%O) Percent of Facility Heated by Oil (%)

(Ceff) Coal Heating Efficiency (%)

(%C) Percent of facility heated by Coal (%)

(otheff) Other Heating Efficiency (%)

(%oth) Percent of facility heated by other (%)

Motors

(HPold) HP Rating of Existing Motor (HP)

(HPnew) HP Rating of Replacement Motor (HP)

(ΔHP) Change in HP Rating (HP)

Cooling

(ΔHP) Difference in Horsepower (HP)

(CDD) Cooling Degree Days (°F)

(Δη) Change in Efficiency (%)

(size) Chiller size (tons)

(ref) Refrigeration (KW/ton)

(Δref) Old Refrigeration – New Refrigeration (KW/ton)

(Tsum) Summer Design Temperature (°F)

(Tcool) Cooling Temperature (°F)

(ΔT) Temperature Difference (°F)

Heating

(eff) Efficiency of Old Boiler (%)

(Reff) Efficiency of Replacement Boiler (%)

(size) Size of Replacement Boiler (MBtu/hour)

(Twin) Winter Design Temperature (°F)

(Theat) Heating Temperature (°F)

(HDD) Heating Degree Days (°F)

Direct Digital Control (DDC)

(#b) Number of Buildings

(sf) Square Footage of Building

(#points) Number of Monitoring and Control Points

($p) Cost per Point ($)

(heat) Heating Load (Btu/sf/HDD)

(Ecool) Cooling Season Electrical Load (KWh/sf)

(Eheat) Heating Season Electrical Load (KWh/sf)

(ΔEcool) Cooling Load Energy Savings (%)

(ΔEheat) Heating Load Energy Savings (%)

(ΔE) Baseline Electrical Load Energy Savings (%)

(Lclg) Length of Cooling Season (Days)

Adjustable Speed Drives (ASDs)

(#) Number of ASDs

($) Installed Cost ($)

(Hrs) Annual Hours of Operation

(flow) Rated Flow

Appendix C: Examples of Life Cycle Cost Analysis Reports

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION	FT MONMOUTH	**REGION NO.**	3	**PROJECT NO.**	1A
PROJECT TITLE	4 Ft Fluorescent Lighting	**ECONOMIC LIFE**	15	**FISCAL YEAR**	2001
ANALYSIS DATE	10/31/00			**PREPARER**	I.M. Saving

1. INVESTMENT COSTS:

A. CONSTRUCTION COSTS	$399,960		
B. SIOH COST	$23,998		
C. DESIGN COST	$23,998		
D. TOTAL COST (1A+1B+1C)	$1,000		
E. SALVAGE VALUE OF EXISTING EQUIPMENT	$447,955		
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D-1E-1F)			$446,955

2. ENERGY SAVINGS (+) OR COST (-):
DATE OF NISTIR 85-3273-12 USED FOR DISCOUNT FACTORS Apr-00

ENERGY SOURCE	**COST $/MBTU(1)**	**SAVINGS MBTU/YR(2)**	**ANNUAL $ SAVINGS(3)**	**DISCOUNT FACTOR(4)**	**DISCOUNTED SAVINGS(5)**
A. ELEC	$26.38	2,926	$77,189	10.86	$838,274
B. DIST	$4.98	0	$0	12.13	$0
C. RESID	$0.00	0	$0	0.00	$0
D. NG	$7.25	(496)	($3,596)	12.61	($45,349)
E. PPG	$0.00	$0	0	0.00	$0
F. COAL	$2.22	0	$0	10.69	$0
G.	$0.00	0	$0	0.00	$0
H. DEMAND			$33,599	10.86	$364,883
I. TOTAL		2,430	$107,192		$1,157,809

3. NON-ENERGY SAVINGS (+) OR COST (-):

A. ANNUAL RECURRING SAVINGS/COST (+/-)			
SOURCE: Maintenance	$5,999		
(1) DISCOUNT FACTOR (TABLE A-2)		11.60	
(2) DISCOUNTED SAVINGS/COST (3A x 3A1)			$69,593

B. NON-RECURRING SAVINGS (+) OR COST (-) ITEM	**SAVINGS (+) COST (-)**	**YEAR OF OCCUR(2)**	**DISCOUNT FACTOR(3)**	**DISCOUNTED SAV/COST(4)**
4 Ft Fluorescent Lighting				
a. First year maintenance	$20,000	1	0.97	$19,340
b.	$0	0	0.00	$0
c.	$0	0	0.00	$0
d. TOTAL	$20,000			$19,340

C. TOTAL NON-ENERGY DISOUNTED SAVINGS (3A2+3B4d)	$88,933
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+(3B1d/YRS ECON LIFE)):	$114,524
5. SIMPLE PAYBACK:	3.90
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):	$1,246,742
SAVINGS TO INVESTMENT RATIO (SIR) (6/1G):	2.79

* Denotes an average based on multiple ECOs/WCOs

Figure C1. Example LCCA Energy Conservation Investment Program (ECIP) report.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY SAVING PERFORMANCE CONTRACT (ESPC)

LOCATION	FT MONMOUTH	**REGION NO.**	3	**PROJECT NO.**	1A
PROJECT TITLE	4 Ft Fluorescent Lighting	**ECONOMIC LIFE**	15	**FISCAL YEAR**	2001
ANALYSIS DATE	10/31/00			**PREPARER**	I.M. Saving

CONTRACTOR'S ECONOMIC ASSUMPTIONS:			
A. PRIVATE BORROWING RATE	10 %		
B. RISK PREMIUM	5 %		
C. TAX RATE ON PROFITS	35 %		
D. ESPC DISCOUNT RATE ((A+B)/(1-C))		18 %	
1. INVESTMENT COSTS:			
A. CONSTRUCTION COSTS	$399,960		
B. SIOH COST	$23,998		
C. DESIGN COST	$23,998		
D. TOTAL COST (1A+1B+1C)	$447,955		
E. SALVAGE VALUE OF EXISTING EQUIPMENT		$1,000	
F. PUBLIC UTILITY COMPANY REBATE		$0	
G. TOTAL INVESTMENT (1D-1E-1F)			$446,955

2. ENERGY SAVINGS (+) OR COST (-):

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$26.38	2,926	$77,189	4.57	$352,598
B. DIST	$4.98	0	$0	5.26	$0
C. RESID	$0.00	0	$0	5.25	$0
D. NG	$7.25	(496)	($3,596)	5.33	($19,170)
E. PPG	$0.00	0	$0	0.00	$0
F. COAL	$2.22	0	$0	4.81	$0
G.	$0.00	0	$0	0.00	$0
H. DEMAND			$33,599	4.57	$153,48
I. TOTAL		2,430	$107,192		$486,906

3. NON-ENERGY SAVINGS (+) OR COST (-):
A. ANNUAL RECURRING SAVINGS/COST (+/-)

SOURCE: Maintenance		$5,999	
(1) DISCOUNT FACTOR (TABLE A-2)	5.09		
(2) DISCOUNTED SAVINGS/COST (3A x 3A1)			$30,546

B. NON-RECURRING SAVINGS (+) OR COST (-)

ITEM	SAVINGS (+) COST (-)	YEAR OF OCCUR(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAV/COST(4)
4 Ft Fluorescent Lighting				
a. First year maintenance	$20,000	1	0.85	$16,949
b.	$0	0	0.00	$0
c.	$0	0	0.00	$0
d. TOTAL	$20,000			$16,949

C. TOTAL NON-ENERGY DISOUNTED SAVINGS (3A2+3B4d)	$47,496
4. FIRST YEAR DOLLAR SAVINGS (2I3+3A+(3B1d/YRS ECON LIFE)):	$114,524
5. SIMPLE PAYBACK:	3.90
6. TOTAL NET DISCOUNTED SAVINGS (2I5+3C):	$534,402
SAVINGS TO INVESTMENT RATIO (SIR) (6/1G):	1.20

* Denotes an average based on multiple ECOs/WCOs

Figure C2. Example LCCA Energy Saving Performance Contract (ESPC) report.

Appendix D: Example DD1391 Report

FY 2001 MILITARY CONSTRUCTION DATA
DD FORM 1391
Page 1

1. **COMPONENT:** Army

2. **DATE:** 10/31/00

3. **INSTALLATION & LOCATION:** FT MONMOUTH - FT MONMOUTH, NJ

4. **PROJECT TITLE:** 4 Ft Fluorescent Lighting

5. **PROGRAM ELEMENT:**

6. **CATEGORY CODE:** 800 00

7. **PROJECT NUMBER:** 1A

8. **PROJECT COST ($000):** 448

9. **COST ESTIMATES:**

Item	U/M	Quantity	Unit Cost	Cost ($000)
2'X4' linear fluorescent luminaire with F32T8 lamps and electronic ballast	Job	1	400	400
Sub-Total				400
Contingency (6.00%)				24
Construction Cost				424
SIOH (6.00%)				24
Utility Company DSM Rebate				0
Total Request				448

10. **DESCRIPTION OF PROPOSED CONSTRUCTION:**
Replace existing 2'X4' F40T12/magnetic ballast fluorescent luminaires with new F32T8/electronic ballast luminaires.

11. **REQUIREMENT:**

A. **Project:**
This project will reduce the electrical energy consumption of facilities by installing more efficient illumination equipment.

B. **Requirement:**
Existing illumination systems are inefficient, have been in service for at least three years, and the replacement project has a payback of ten years or less.

C. **Current Situation:**
Existing systems consume excess electrical power compared to other available technologies which can improve lighting quality while reducing energy consumption.

D. **Impact if not Provided:**
The installation will continue to sacrifice potential saving in energy dollars, in reduced maintenance costs, and may not meet federally mandated energy reduction goals.

Figure D1. Sample DD1391 report.

CERL Distribution

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11
6/00

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14. ABSTRACT

Department of Defense "Military Construction Data" form DD1391 includes no template for energy calculations and project narratives. The Energy Manager Project Assistant (PA) software program, an offshoot of the Renewables and Energy Efficiency Program (REEP), was created to fill this gap by providing a standard template for DD1391 energy project calculations and narratives. The energy and water conservation opportunities in REEP that generate the most savings were modified and included in PA. PA calculates resource and cost savings and generates DD1391 forms and supporting LCCA forms. Other benefits to the PA program in addition to quick, accurate, and consistent project preparation include accurate "what-if" analyses of individual conservation opportunities within a building or set of buildings, and its capability to evaluate Energy Savings Performance contract (ESPC) proposals for estimated energy/cost savings. This work provides documentation for the Energy Manager Project Assistant, to help energy managers create correct, complete DD1391 energy project calculations and narratives.

15. SUBJECT TERMS

water conservation	installation management	life cycle cost analysis (LCCA)
energy conservation	DD1391	

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